ROHDE&SCHWARZ

Measuring Instruments
and Systems Division

Manual

POWER SENSOR
NRV-Z4

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The Power Sensor NRV-Z4 is used together with the basic unit NRV or with the Millivoltmeter URV5 for power measurements in **50-Ω systems** ranging from **500 pW to 20 mW** at frequencies from **100 kHz to 6 GHz.** Because of its high sensitivity, the sensor may be easily destroyed when handled improperly. Therefore, never exceed the following limits:

Max. permissible power (CW/PEP)	100 mW	
	AC voltage	2.3 V

Since the 50-Ω termination is directly connected to the inner conductor, the total power (RF + DC) must not exceed the indicated 100 mW limit.

Contrary to other power meters, the probes of which are first to be calibrated with a reference power, the NRV-Z4 is ready for operation immediately after connection. Each sensor is equipped with a memory holding the individual calibration parameters. In the LOCAL mode the basic unit reads out these data automatically as soon as the sensor is connected. In the REMOTE mode, this procedure must be triggered **once** with the IEC-bus command CØ prior to the first measurement (see also sections 2.3.1, 2.3.2 and 2.4.3 of NRV manuals). In both cases, **init** appears during the readout of calibration parameters.

For detailed description of the sensor, please refer to section 2, **Measurements with the NRV-Z4.** A list of possible error sources in RF power measurements and hints for selecting the appropriate sensor can be found in section 3, **Error Analysis.** Operation of basic unit and the total IEC-bus syntax are described in the NRV (or URV5) manual.

2 Measurements with the NRV-Z4

2.1 Measurement Principle

The high-frequency sensor includes two zero-bias-Schottky diodes of latest technology and stable physical characteristics. In the power range from 500 pW to 10 µW (-20 dBm), this detector behaves like a microwave power meter. The measured data are independent of the waveform and in the case of modulated signals, the average power is indicated. In older power meters using diodes, the upper limit of the measurement range is determined at the same time. With the power sensors of the NRV family, the non-linear detector characteristic can now be linearized for greater powers (10 µW to 20 mW for the NRV-Z4).

The respective parameters are included in a set of calibration data which are determined for each individual sensor during production and then stored in the pertaining data memory. Although in the extended measurement range - particularly near the upper limit - peak instead of rms weighting is carried out to an increasing extent, RF power measurements can be made with full accuracy provided that a few rules are observed. The spectrum of the RF signal should be pure (low content of harmonics and spurious responses) and, in the case of average-power measurements, it should not be amplitude-modulated. Above 1.5 GHz, an additional error caused by the signal-level-dependent junction capacitance must be taken into account (see specifications).

In addition to the above-mentioned linearity characteristics, the sensor-specific data memory holds temperature correction values and calibration factors for frequency response correction. While temperature compensation is automatic due to cyclic temperature measurements in the sensor, the test frequency must be entered (via keyboard or IEC bus) if the respective calibration factors are to be taken into account.

2.2 Readout and Reference Impedance (see also section 2.3.5 of NRV manual)

The measured data can be read out as absolute value in W, **dBm** and **V, dBV** or relative to a stored reference value or to the value measured in the second channel. Conversion between the first two units and the voltage is made via the reference impedance Z_0:

$$\text{Voltage/N} = \sqrt{\text{power/W} \times \text{reference impedance/}\Omega} \qquad (2\text{-}1)$$

The 50-Ω reference impedance of the NRV-Z4 is stored when the data memory is read into the basic unit. The value is indicated when the **RLC INP** key is pressed or written into the output buffer with IEC-bus command **Z1** (see also sections 2.3.5.6 and 2.4.3.2 of NRV manual). It must be emphasized that the reference impedance is the nominal value of the terminating impedance of the sensor and not the true value of the impedance. Therefore, the displayed voltage is not the voltage at the sensor but the rms value of a wave the power of which is measured in a 50-Ω system.

2.3 Measurement Speed and Noise

With older power meters, there is often a relationship between measured power and bandwidth; the smaller the power the narrower the bandwidth. This certainly reduces the noise, but extends the settling time and consequently the useful measurement speed. This relation is extremely useful in manual operation but a disadvantage with remote control. Even in cases where higher noise levels have no effect, the measurement cannot be speeded up. In addition, the user has to determine the required waiting times in order to obtain settled test results.

A different concept has been chosen for the NRV. The user is able to select one of six filters via keyboard or IEC bus (see also sections 2.3.8, 2.3.10, 2.4.3.1 and 2.4.3.2 of NRV manual). Measurement speed and noise for each setting are indicated in the Specifications.

The response times for remote control via IEC bus specified for triggered measurements represent the period between the actual triggering and the output of the first byte. Since internal settling times have already been taken into account, settled measurement results are obtained provided that the test signal is not varied after triggering. To make sure that the response of the instrument in the LOCAL mode is not too slow - particularly when switching from FØ to F2 - intermediate results are displayed. For instance, if filter FØ has been selected in LOCAL operation, a new parameter is indicated every second; in the case of a sudden variation of the test signal, the final result is only indicated after about 15 s. The display noise is halved or doubled between two filter settings. In practice it has proved useful to select either **F2** or **F4** with the **FILTER** key (FILTER key illuminated).

In the case of two-channel measurements, the filter can be selected separately for each channel. Since the individual measurements are stacked, the total measurement time is shorter than the sum of the individual measurement times. For instance, with single-channel measurement, the exact measurement time is 0.92 s, and 1.65 s in the case of two-channel measurements.

Since it often happens that low level is measured in one channel only (requiring low display noise), it will be sufficient to use F2 in this channel and, for instance, select F4 in the second. In this case, the total measurement time is 1.00 s.

Table 2-1 shows permissible filter settings for a display noise error of max. 1% (2 standard deviations - see also section 3.5).

Table 2-1 Filter settings for an error of 1% caused by display noise

	2 nW	4 nW	8 nW	16 nW	32 nW	100 nW	20 mW
FØ	x	x	x	x	x	x	
F1		x	x	x	x	x	
F2			x	x	x	x	
F3				x	x	x	
F4					x	x	
F5						x	

2.4 Zeroing (see also section 2.3.4 of NRV manual)

In addition to the noise, an additive offset of positive or negative polarity may falsify the test result when small powers are measured. This error may be caused for instance by thermal voltages or by switching offsets in the NRV. Under normal conditions, this error will not exceed ±500 pW so that an adjustment is superfluous with powers above 50 to 500 nW. Zeroing is initiated by pressing the **ZERO** key or via IEC bus command **O1**. With filter settings F1 to F5, about 4 s are required for the adjustment and 15 s for FØ. During zeroing, four points light in the display, then **the ZERO** key lights. The remaining offset must not exceed ±50 pW or ±25 pW with FØ. By pressing the **ZERO** key once again or with IEC-bus command **OØ**, the offset adjustment can be cancelled. Basically an offset adjustment can be triggered any time, but for reliable adjustment it is advisable to first warm up the basic unit for at least one hour with the sensor connected for a minimum of half an hour. In addition, please note:

Disconnect sensor from the signal source and switch off the RF power!

Zeroing not immediately after measuring higher powers!

Do not move the sensor connecting cable during zeroing!

2.5 Selection of Measurement Range (see also section 2.3.7 of NRV manual)

Generally, it is advisable to use autoranging (**AUTO** key illuminated). However, in some applications it might be better to keep the set measurement range (via keyboard only, **AUTO** key) or to select a range as required.

Range setting via keyboard with the **UP** ↑ and **DOWN** ↓ keys; in the case of remote control with IEC-bus commands RG1 to RG3.

The NRV uses 20-dB steps for range setting (see also Table 2-2). With range selection or holding via keyboard, the new measurement range (as shown in Table 2-2) is briefly indicated in the display. The indicated value corresponds to the voltage pertaining to the nominal power of the selected range according to formula (2-1).

Table 2-2 Measurement ranges

Nominal range	2 µW	200 µW	20 mW
Display range	500pW to 2.9 µW	2 µW to 290µW	200µW to 22 mW
IEC-bus command	RG1	RG2	RG3
Display with range selection via keyboard	10×10^{-3}	100×10^{-3}	1

2.6 Frequency-response Correction

For each NRV sensor, the ratio between displayed and applied power - the so-called calibration factor - is determined during production at a great number of calibration frequencies (see Specifications). These factors are stored in the data memory of the sensor and read in by the basic unit during initialization. Consideration of calibration factors is troublesome with all competitive instruments: the values must be read from a diagram, i.e. additional interpolation is required. Then the value is set with a rotary knob on the basic unit or entered numerically. With the NRV, one merely needs to enter the test frequency via keyboard or IEC bus (see also sections 2.3.5.4, 2.3.9.1 and 2.4.3 of NRV manual) **and** to switch on the frequency response correction with **the FRQ CORR** key or the IEC-bus command **KF1.**

The NRV then finds the corresponding calibration factors and interpolates linearly between two values if the entered frequency is between two calibration frequencies. In the event that a test frequency has been entered which is outside the calibration frequencies, the calibration factor pertaining to the respective limit frequency will be considered. No extrapolation will be made.

In all cases where frequency response correction is switched off (by pressing the **FRQ CORR** key or via IEC-bus command **KFØ** - key illumination goes out), the instrument automatically uses the calibration factor at **50 MHz.** Thus measurements up to about 1 GHz can be carried out with a relatively small additional error. This error is not specified in the data sheet.

2.7 PEAK(PEP) Measurements

With the NRV sensors, the peak power can be measured provided that no fast pulses are present. After pressing the **PEAK(PEP)** key or selecting IEC-bus command **E1** (PEAK(PEP) key illuminated), the NRV indicates the maximum power of a modulated signal. In the case of an unmodulated RF, there is no difference to the normal measurement - beside the noise at very low powers. The monitoring interval of the crest-value meter in the NRV can be switched together with the filter setting so that, particularly with FØ to F3 signals of very low pulse repetition rate can be measured (see PEP measurement in the Specifications).

With pulse-modulated RF (see Fig. 2-1), the permissible pulse width may be within about 200 µs and CW. The filter effect of the rectifiers in the sensors and the limited bandwidth of the DC amplifier in the NRV cause an additional error particularly in the case of narrow pulses (see Fig. 2-2). The values in the diagram apply to $t_p << T$, i.e. an RF pulse of 200 µs can be measured with fair accuracy even if the pulse occurs only at every 20 s (filter FØ)! In the case of higher powers and high pulse rate (T/2 = approx. t_p), the occurring errors are always smaller than specified in Fig. 2-2 (peak-weighting of detector, see section 3.6). Thus it causes no problems to measure signals with a pulse width far below 200 µs.

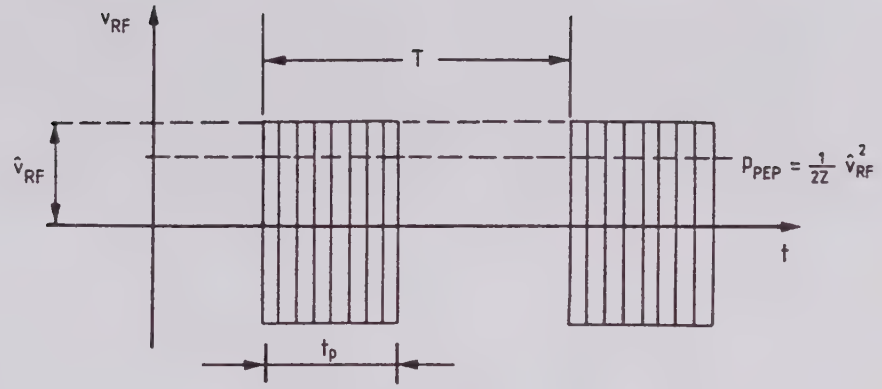

Fig. 2-1 Pulse-modulated RF voltage

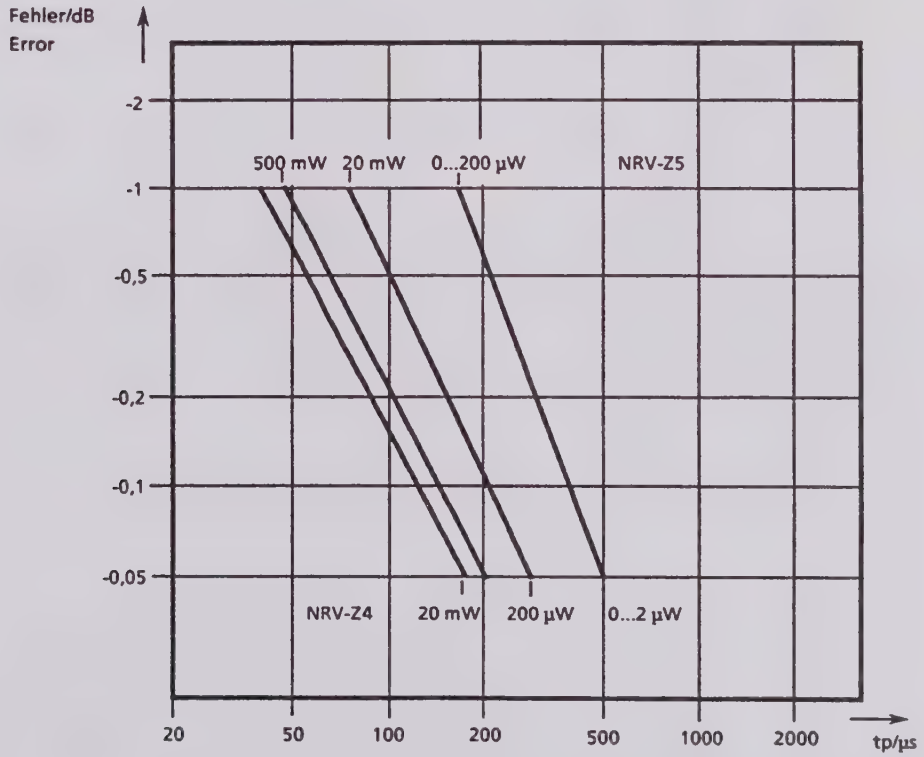

Fig. 2-2 Typ. weighting error with PEAK(PEP) measurements of pulse-modulated RF at various displayed values

3 Error Analysis

3.1 Matching Error

In this section, attention is drawn to an error which is normally ignored because it cannot be stated in the specifications. It is caused by mismatch of power meter and source - which is generally the case in normal practice - and may reach the magnitude of the specified errors. In order to clarify this effect, the behaviour of an ideal power meter (see Fig. 3-1) will be examined.

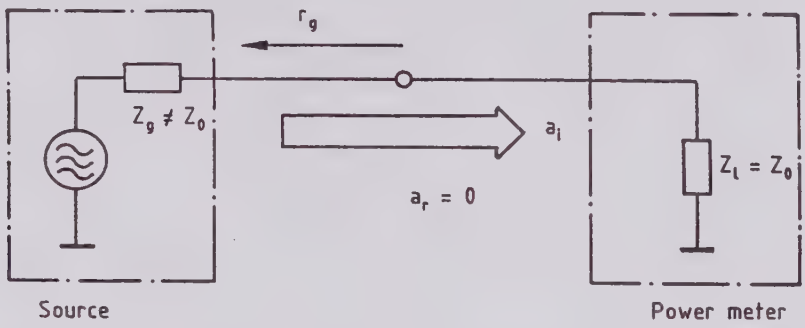

Fig. 3-1 Power measurement with matched power meter

The wave a_i from the generator applied to the line with a reference impedance Z_0 is absorbed reflection-free by the power meter whose impedance Z_l fully matches the reference impedance. **The power meter measures the power the source is able to supply to a load with Z_0.** It must be emphasized that this is not the maximum available power that can be delivered in the case of conjugated complex load matching.

Fig. 3-2 shows a case commonly met in practice where part of the applied power is reflected by the power meter.

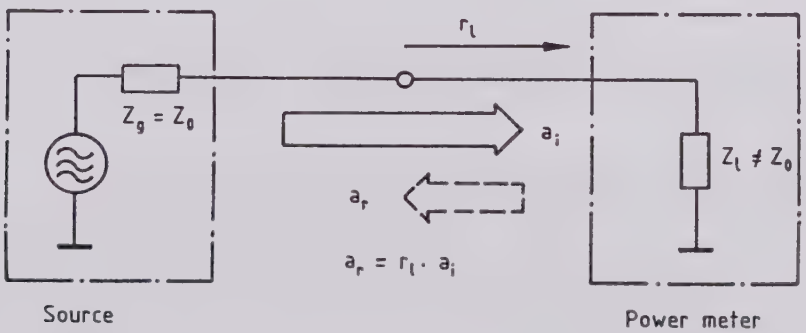

Fig. 3-2 Power measurement with matched source

Suppose that in this special case the generator is matched and the reflected wave is completely absorbed by the source. It is obvious that not the full power the generator could deliver to a matched load is absorbed by the power meter. This measurement error - the so-called **mismatch loss** - may be considered when calibrating the power meter so that it becomes irrelevant to the user.

A realistic case of power measurement with mismatch at both ends is shown in Fig. 3-3.

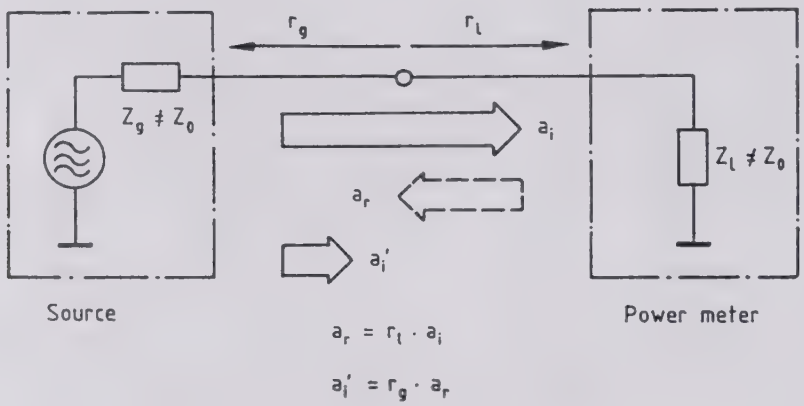

Fig. 3-3 Power measurement with mismatch at both ends

Because of a second reflection - at the generator end - the wave a_i' is added to the wave a_r reflected by the power meter. It is superimposed to the incident wave a_i whose intensity is increased, reduced or unaffected depending on the phase position. Since generally the phase of the wave reflected by power meter and source is unknown, the error caused by multiple reflection cannot be specified. However, it is possible to calculate the maximum possible error, the so-called mismatch uncertainty M_u. Without derivation, the following formula is given:

$$M_u/\% = 100 \left\{ \frac{1}{(1 \pm r_g\, r_l)^2} - 1 \right\} \qquad (3\text{-}1)$$

The following approximation is possible:
$M_u/\% \approx \pm 200\, r_g\, r_l$

An example in practical application:

Generator: $r_g = 0.20$ (SWR 1.50)

Power meter: $r_1 = 0.05$ (SWR 1.11)

$M_u = \pm 2.0\%$

This means that in addition to all other errors the user must take an uncertainty of ±2% into account. Supposing the source is already available, the matching error can only be influenced if a low-reflection power sensor is used.

3.2 Error Limits of Calibration Factor

Each NRV power sensor is measured during production at a variety of calibration frequencies (see Specifications: **Error limits of calibration factor**); the measured power is compared to the reference power from the calibration system and the ratio between the two values is stored in the form of a **calibration factor.** Whenever use is made of frequency-response correction, the measured data are first multiplied with the calibration factor pertaining to the frequency. To this end, a linear interpolation is carried out between two calibration frequencies. With instruments of other make, the calibration factor (**Cal factor**) must be taken from a diagram and then set on the instrument or entered.

There are certain inaccuracies when determining the calibration factor in production, caused by the calibration system and by mismatch. R&S specifies in the technical data a maximum error (**worst case uncertainty**) and the RSS [1]) error (**RSS uncertainty**) at the individual calibration frequencies for specific frequency ranges. The maximum error is the algebraic sum of all maximum error values. The RSS error is determined by adding the squares of the individual errors and then taking the square root (see section 3.9: Maximum and RSS Error). While the maximum error allows a fairly conservative error estimate, the RSS error informs on the size of the error to be expected in practice.

All calibration facilities used during production of the NRV sensors are directly derived from the respective national primary standards (PTB, NBS).

The calibration factors are determined at various powers depending on the individual sensor (see Table 3-1).

Table 3-1 Measured power for determining the calibration factor

NRV sensor	Z1	Z2	Z3	Z4	Z5
Measured power	12.6 µW	1 mW	26.8 µW	10 µW	1 mW

[1]) RSS: Root sum of the squares

3.3 Linearity Error

With an ideal power meter, the relation

$$P_{dis} = K_b \times P_{inc} \qquad (3\text{-}2)$$

applies at a certain frequency over the entire dynamic range between the displayed power P_{dis} [1]) and the power of the incoming wave P_{inc}. K_b is the calibration factor; matching errors are ignored. With real-power meters, this formula only applies at the calibration point (see Fig. 3-4). Towards lower and particularly higher powers, deviations from these physical characteristics may occur, the linearity error E_l:

$$E_{lin/\%} = 100 \ \{P_{dis}/(K_b P_{inc}) - 1\} \qquad (3\text{-}3)$$

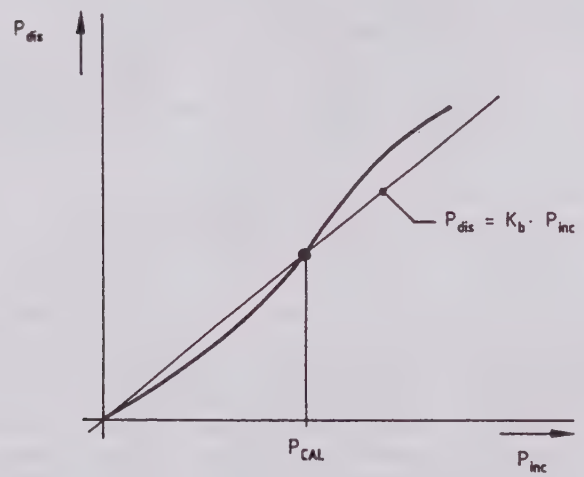

Fig. 3-4 Linearity error

The linearity error may be added to the previously mentioned errors without further conversion. R&S specifies the linearity error for a calibration temperature 23 ± 1°C at 50 MHz. With 0.3 to 0.4%, this error is relatively small compared to that of competitive equipment which have no facility for individual linearization of the sensor.

For the two power sensors NRV-Z1/-Z2 (-Z4/-Z5) the specified linearity error applies for a frequency up to 4(1.5) GHz. For higher powers (>20 µW for NRV-Z1/-Z4, >2 mW for NRV-Z2/-Z5) an additional error caused by the power-dependent junction capacitance of the detector may occur. The error increases with increasing frequency and power to be measured. Therefore the specified data must only be expected at the upper limits of the respective intervals. Fig. 3-5 shows the power and frequency-dependent measured reaction of NRV-Z1/-Z2. The error always has a positive sign, i.e. it increases the displayed power.

[1]) Without frequency-response correction

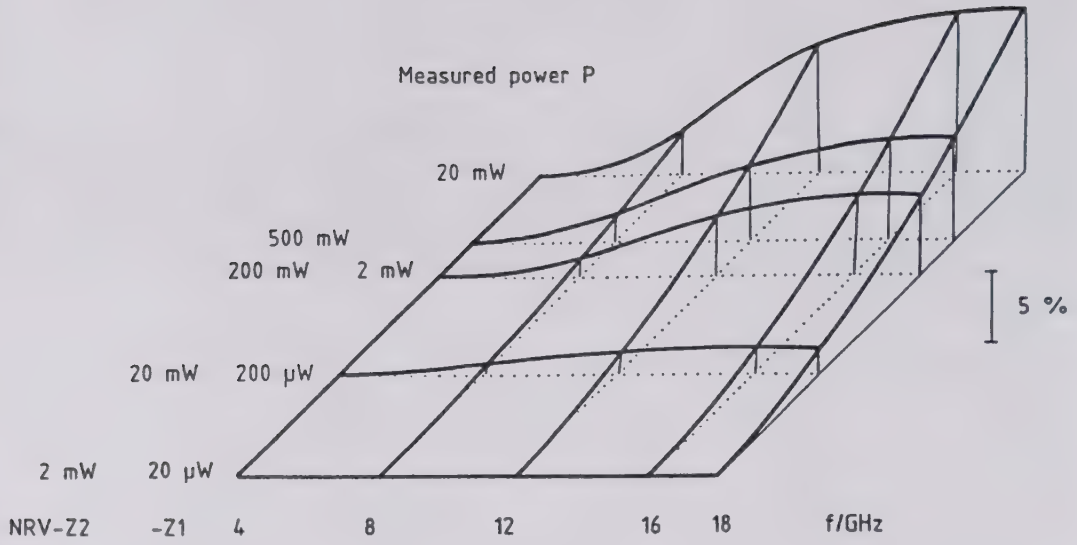

Fig. 3-5 Frequency-dependent additional error

3.4 Zero Error

The zero error is a residual error after zeroing causing an additive (power) offset which is almost invariable with time and only slightly influenced by the ambient temperature as long as no sudden temperature changes occur. In the R&S specifications, the zero error is a maximum error that may occur within one hour after zeroing, changes in ambient temperature of ±1 °C being permissible.

If zeroing is carried out while filter FØ is selected, half the value may be expected for a brief period of time (see section 2.4).

3.5 Display Noise

Since this is a random noise, no maximum values can be specified. For this reason, R&S specifies a value which is twice the standard deviation. Consequently it can be assumed with a 95% certainty that the measured value will not deviate from the indicated average power by more than this amount. The measurement is carried out with filter setting F2 for about 1 min. (64 measured values, trigger mode X4). The standard deviation s may then be calculated according to the formula

$$s = 1/8 \sqrt{\sum_{i=1}^{64} (P_i - \overline{P})^2} \qquad (3\text{-}4)$$

P_i = individual measurement

$\overline{P}$ = average value of 64 individual measurements

Like the zero error, the display noise is an additive quantity independent from the measured power.

3.6 Weighting Error

An ideal power meter displays the true power of the input signal independent of the waveform. Although no sawtooth or squarewave voltages are measured at high frequencies, distorted sinewave signals comprising harmonics or even spurious resonances must be expected. In this case, the microwave power meter is ideal. It measures the total power i.e. the sum of the individual powers measured at the various frequencies. Even if only the power of the fundamental is of interest, the error caused by unwanted components is low considering that a noise signal of -26 dBc increases the power indication by only 0.25%.

The behaviour of sensors with diodes such as NRV-Z1...Z5 is less ideal over the entire dynamic range. While small powers are measured with true rms values (as in the microwave power meter), peak weighting of the input signal is carried out to an increasing extent towards the upper range limit. Under unfavourable conditions, an interfering signal of -26 dBc may cause an error of ±10% in power indication.

Table 3-2 shows limits for the power ranges in which powers are measured with true rms values or in which weighting errors must be expected.

Table 3-2 Weighting

Sensor	Rms weighting	Weighting error possible	k
-Z1/-Z4	1 nW to 10 µW	10 µW to 20 mW	1.0
-Z2/-Z5	100 nW to 1 mW	1 mW to 500 mW	0.01
-Z3	400 pW to 7 µW	7 µW to 13 mW	1.5

With the aid of formula (3-5), the error caused by one single noise component can be assessed.

$$E_w/\% = \frac{200}{1 + 200\ \mu W/kP} \times 10^{S/20\ dB} \qquad (3\text{-}5)$$

E_w: Error of power indication

P: Measured power

k: see Table 3-2

S: S/N ratio in dB

Example: Measurement with NRV-Z2, P = 100 mW, S = -32 dBc

Result obtained with formula (3-5): $E_w = \pm 4.2\%$

Formula (3-5) applies very exactly to the error at the 3-fold fundamental frequency (3rd harmonic). For the 2nd harmonic, the resulting error is somewhat greater; for all higher harmonics, the errors are smaller than calculated with formula 3-5.

In the case of power sensors NRV-Z3...Z5, the even harmonics of low order (double, 4-fold, 6-fold fundamental frequency) produce negligibly small weighting errors because of the full-wave rectification used.

3.7 Error of Basic Unit

The analog section of the NRV mainly consists of highly accurate DC amplifiers and a high-resolution A/D converter. The specified error is caused by the drift of the gain ratios (time, temperature) and like all other errors it is referred to the measured value. Since normally the typical error is even smaller, the error caused by the basic unit may be neglected in comparison to the other uncertainties of measurement.

3.8 Temperature Effect

Outside the range from 18 to 28 °C, an additional error may occur in the basic unit (maximum error specified).

Without correction, the sensors have a very high temperature coefficient that lies between -0.3 and -0.5%/°C. With the aid of cyclic temperature measurements in the sensor and a correction software based on a diode model matched to the specific sensor, the residual error can be reduced to typically 0.07%/°C. The typical errors to be expected in various frequency ranges and guaranteed maximum values are given in the Specifications.

3.9 Maximum and RSS Error

Specifying errors for a specific test setup is basically a matter of trustworthiness. Error calculation is simple if only a few parameters are concerned, but in the case of measurements involving a large number of error sources, the discrepancy between the maximum calculated error and the error actually incurred will become evident.

For this reason, two errors are usually stated when making power measurements: the maximum error E_{max} as sum of all individual maximum errors $(E_{max})_i$ (see formula (3-6)) and the so-called E_{RSS}, a more practice-oriented error (formula (3-7)).

$$E_{max} = \sum_{i=1}^{N} (E_{max})_i \qquad (3\text{-}6)$$

$$E_{RSS} = \sqrt{\sum_{i=1}^{N} (E_{RSS})_i^2} \qquad (3\text{-}7)$$

The RSS value is the square root from the sum of squares of the individual RSS errors $(E_{RSS})_i$. If only the maximum value is available for one of the error components, it should be inserted in the formula (this will generally be the case). It must however be noted, that only **average-free** error components may be used in RSS calculations; i.e. an error of for instance +0.8% must be as probable as an error of -0.8%. This can be assumed for all error components except for the frequency-dependent additional error described in section 3.3. How can this frequency-dependent additional error be considered in the RSS calculation? First determine the RSS value from all other components and then add the mentioned error.

Example:

$(E_{max})_1 = \pm 2.8\%$ $(E_{max})_2 = \pm 2.5\%$ $(E_{max})_3 = \pm 1.5\%$

$(E_{RSS})_1 = \pm 1.6\%$

Suppose the frequency dependent additional error
$(E_{max})_4 = +3.0\%$

$E_{max} = -3.8/+9.8\%$ $E_{RSS} = -0.3/+6.3\%$

The definition of the RSS value, which seems at first arbitrary, is based on a known law of the probability calculus: with a total error representing the sum of several individual errors, the sum error approaches the Gaussian distribution as the number of error components increases. The standard deviation of the sum error equals the square root of the sum of squares for the individual standard deviations. This is fairly accurately in agreement with the law for the RSS value with the only difference that the RSS or maximum value is used instead of the standard deviation. Depending on the distribution function of the individual errors, the RSS value corresponds to 2 to 3 standard deviations; this also applies to the result obtained.

Consequently:

The RSS value of a sum of individual errors can be regarded as the error which is not exceeded in 95% of all measured data.

3.10 A Practical Example of Error Analysis

Given quantities:

Generator $r_g = 0.15$ (SWR 1.35)
$P = 10\ \mu W/12\ GHz$

Power meter NRV-Z2, filter F4 $T_a = 24\ ^\circ C$

The individual errors have been taken from the NRV/NRV-Z2 specifications.

Error source	Manual	Component (E_{max})		Component (E_{RSS})
		%	dB	%
Matching $r_g = 0.15$ $r_l = 0.07$	Formula (3-1)	±2.1	-0.0927 +0.0907	±2.1
Cal factor ±5.4% (±2.8%)	Section 3.2	±5.4	-0.2284 +0.2411	±2.8
Linearity	Section 3.3	±0.3	-0.0130 +0.0130	±0.3
Zero point ±10 nW	Section 3.4	±0.1	-0.0043 +0.0043	±0.1
Noise 64 nW	Section 3.5	±0.6	-0.0279 +0.0277	±0.6
Basic unit	Section 3.7	±0.3	-0.0130 +0.0130	±0.3
Weighting	Section 3.6	±0.0	-0.0000 +0.0000	±0.0
Temperature	Section 3.8	±0.0	-0.0000 +0.0000	±0.0
Total error		**±8.8**	**-0.3793 +0.3898**	**±3.6**

If the total error in dB is converted into the corresponding error in %, the result is -8.4/+9.4%. The difference to the specified value of ±8.8% is due to the fact that, strictly speaking, formula (3-6) is only an approximation of the sum of relative errors.

3.11 List of Symbols Used

a_i [1]	Incident wave with matched generator
a_i' [1]	Component of incident wave resulting from multiple reflection
a_r [1]	Reflected wave
E_{lin}	Linearity error
E_w	Weighting error (only with power measurement with semiconductor diodes)
E_{max}	Maximum value of total error
E_{RSS}	RSS value of total error
f	Frequency
i	Index for identification of an individual measurement or an error component
k	Scaling factor (formula 3-5)
K_b	Calibration factor
M_u	Mismatch uncertainty
P	Power, general
P_{dis}	Displayed power
P_{inc}	Power of incident wave
P_{PEP}	Max. peak envelope power
$\overline{P}$	Average value of several power measurements
r_g	Reflection coefficient of generator
r_l	Reflection coefficient of load

[1] The wave magnitudes a_i, a_i', and a_r are complex pointers for representation of the wave propagation referred to magnitude and phase (network analysis with s-parameters). The following relation exists between a wave a and the power P transported by a:

$$/a/ = \sqrt{P}$$

s	Standard deviation of display noise
S	S/N ratio
T	Period
t_p	Pulse width
T_U	Ambient temperature
u_{HF}	RF voltage, instantaneous value
$\hat{u}_{HF}$	RF voltage, peak value
Z_g	(Internal) impedance of generator
Z_l	Impedance of load
Z_0	Reference impedance (real)

4 Checking the Rated Characteristics

Power and reflection measurements in the frequency range up to 18 GHz require experience and special care because of the manifold error sources.

For this reason, the guaranteed characteristics should only be measured by the respective calibration or service shops of Rohde & Schwarz where suitable test setups are available for such measurements. If the user still wishes to carry out these measurements on his own, he should in any case be well aware of the measurement uncertainties of the chosen test setup. A careful study of section 3 is recommended in this case.

5 Maintenance and Service

The NRV sensors require no maintenance and offer stable electrical characteristics. A yearly check will be sufficient (section 4).

Defective probes or those out of tolerances must be returned to the manufacturer for repair/calibration.

At present, only the manufacturer is able to enter the calibration parameters into the data memory.

The date of the last calibration can be output using the special command SP (see NRV manual, section 2.4.3).

ROHDE&SCHWARZ

Liste mechanischer Teile

List of mechanical parts

Bilder zur Liste mechanischer Teile

Figures pertaining to list of mechanical parts

R 44830

Liste zu Bild 5-1

List for Fig. 5-1

Lfd. Nr. No.	Kenn-zeichen Unit/ Comp.No	Stück-zahl Qty	Benennung/Beschreibung Designation	Sachnummer Stock No.
1	W1	1	DX Kabel Cable (VAR/MOD 02) DX Kabel, 5 m lang Cable, 5 m length (VAR/MOD 03)	828.3476.02 828.3476.05
2		1	ED Datenspeicher Data memory	395.2915.02
3		1	Unterteil, metallisiert Bottom plate, metal-coated	395.0612
4		1	Oberteil, metallisiert Top plate, metal-coated	395.0635
5		1	VS M 2x10 DIN 7985 A4	VS 081.8942
6		1	VS M2 DIN 934 A4	VS 061.5225
7		4	VS M 2x6 DIN 7985 A4	VS 081.8920
8		1	MZ Kontaktfeder Contact spring	395.0658
10		1	MZ Deckel Cover plate	358.2321
11		4	VS M 2x5 DIN 7985 A4	VS 088.3123
12		1	MP Tastkopfschale, oben Probe casing, top	238.2883
13		1	MP Tastkopfschale, unten Probe casing, bottom	238.2890
14		1	OS Schild, mit SER-Nr. Label with serial number VAR/MOD 02 VAR/MOD 03	828.3682 828.3699

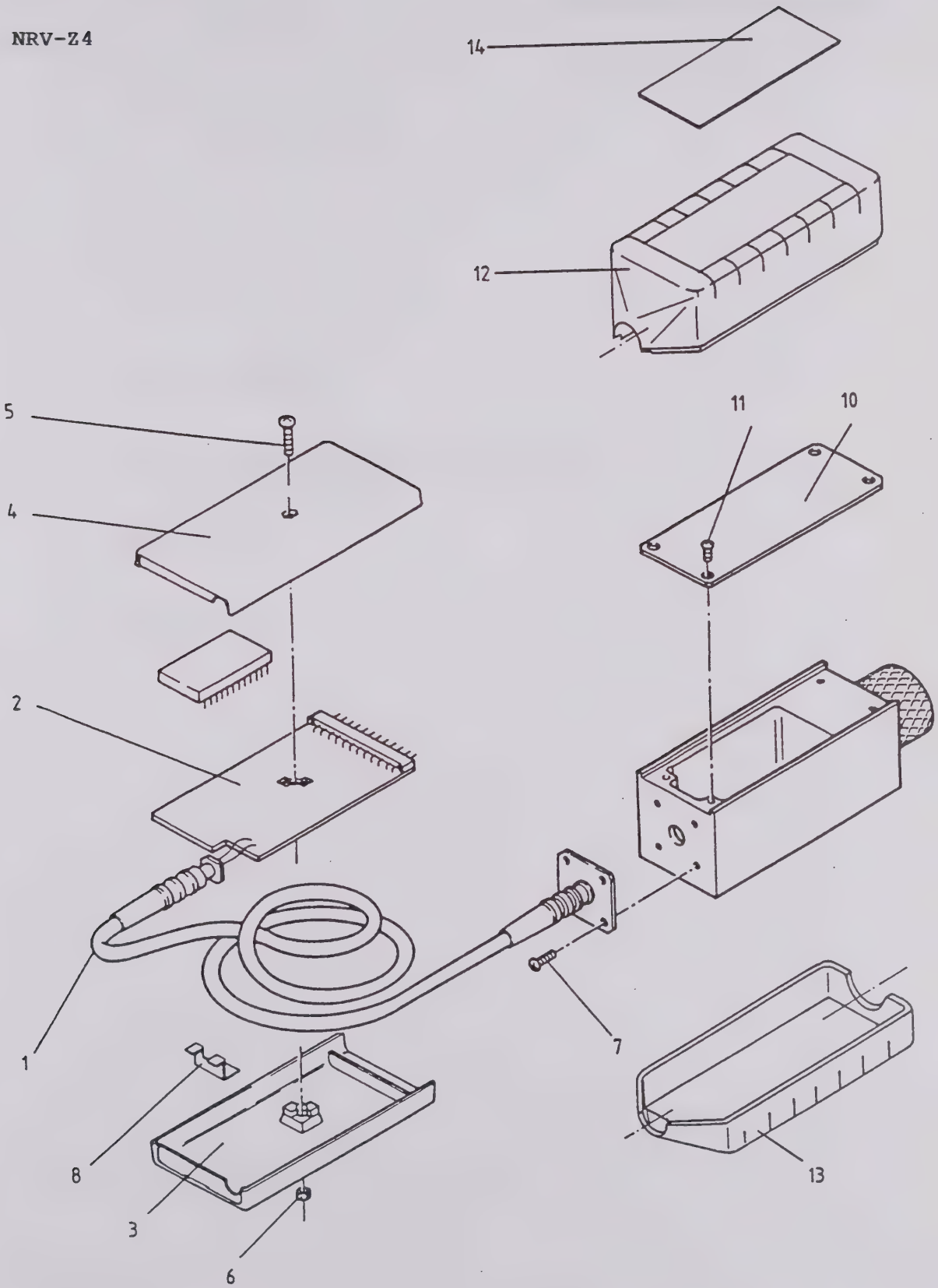

Bild 5 - 1
Fig. 5 - 1

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Unternehmensbereich
Meßgeräte und Meßsysteme

Beschreibung

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828.3618.03

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Power Sensors NRV-Z

For RF and microwave power measurements

- Thermal sensors and diode sensors for high-precision power measurements
- Compatible with NRVS, NRVD, URV35 and URV55 basic units
- Frequency range DC to 40 GHz
- Power range 100 pW to 30 W
- Standards: GSM900/1800/1900, DECT, IS-95 CDMA, W-CDMA, NADC, PDC, DAB, DVB, etc
- Absolute calibration, simply plug in and measure
- Calibration data memory for sensor-specific parameters
- High long-term stability
- Excellent temperature response

ROHDE&SCHWARZ

With its large variety of power sensors Rohde&Schwarz is able to provide the right tool for power measurements with NRVS, NRVD, URV35 and URV55 basic units.

15 different types of power sensors in all cover the frequency range from DC to 40 GHz and the power range from 100 pW (–70 dBm) to 30 W (+45 dBm). In addition to thermal sensors, which are ideal as a high-precision reference for any waveform, diode sensors with a dynamic range of more than 80 dB are available.

The peak power sensors of the NRV-Z31/-Z32/-Z33 series allow power measurements on TDMA mobile phones to different digital standards as well as measurement of the peak power of pulsed or modulated signals.

Plug in and measure

With the individually calibrated sensors of the NRV-Z series plugged into the basic unit, a fully calibrated power meter is immediately ready for measurements – without need for entering calibration factors and without adjustment to a 50 MHz reference: this means a great benefit in the routine research and development work and an error source less when changing the sensor. These assets are brought about by the calibration data memory first introduced by Rohde&Schwarz which contains all the relevant physical parameters of the sensors, and the excellent long-term stability of the Rohde&Schwarz power sensors. Rohde&Schwarz is worldwide the only manufacturer to provide absolute calibration for its power sensors.

The right sensor for every application

Terminating power sensors are used for power measurements on a large variety of sources. The requirements placed on the sensor regarding frequency and power range, measurement accuracy and speed may therefore differ a great deal.
Four classes of power sensors allow optimum adaptation to the specific measurement task:

- Thermal power sensors NRV-Z51/-Z52/-Z53/-Z54/-Z55
- High-sensitivity diode sensors NRV-Z1/-Z3/-Z4/-Z6/-Z15
- Medium-sensitivity diode sensors NRV-Z2/-Z5
- Peak power sensors NRV-Z31/-Z32/-Z33

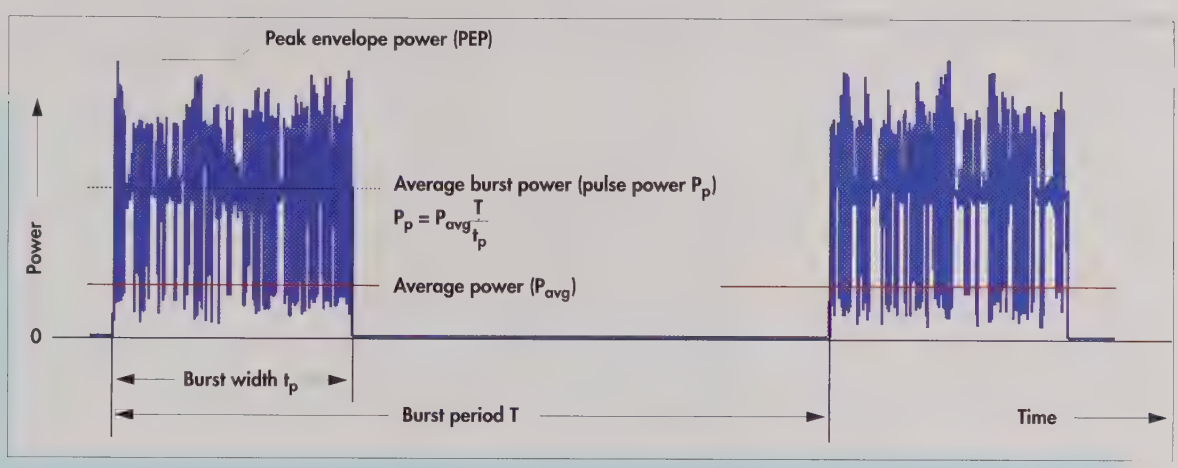
Thermal power sensors

The thermal power sensors of the **NRV-Z51** to **-Z55** series satisfy the most stringent demands placed on measurement accuracy and matching. They cover the power range from 1 µW (–30 dBm) to 30 W (45 dBm) and the frequency range from DC to 40 GHz.

These sensors are capable of measuring – without any degradation of the measurement accuracy – the power of CW signals as well as the average power of modulated or distorted signals by RMS weighting of all spectral components within the specified frequency range. Therefore, thermal sensors are the first choice for power measurements at the output of power amplifiers and on carrier signals with modulated envelope. Needless to say that the linearity of the sensor is independent of frequency, ambient temperature and waveform, and with 0.5% or 0.02 dB its contribution to the measurement uncertainty of sensors NRV-Z51/-Z52/-Z55 is negligible.

High-sensitivity diode sensors

The high-sensitivity power sensors **NRV-Z1/-Z3/-Z4/-Z6/-Z15** based on zero-bias Schottky diodes open up the power range below 1 µW down to the physical limit of 100 pW (–70 dBm). In this range, strictly speaking from –70 dBm to –20 dBm, their behaviour is much the same as that of thermal sensors, ie precise measurement of the average power of modulated signals, RMS weighting of harmonics and



Definition of the main power parameters using the transmitter signal of a NADC mobile station as an example. The average burst power can be displayed on the NRVS, NRVD and URV55 basic units after entering the duty cycle t_p/T. Required is a sensor that is able to precisely measure the average power P_{avg}, ie a thermal sensor or a diode sensor operated in the square-law region.

linearity independent of temperature and frequency.

All high-sensitivity sensors from Rohde&Schwarz are calibrated to allow precise power measurements also outside the square-law region up to a power of 20 mW (+13 dBm). The high signal-to-noise ratio of the sensor output signal in this region makes for very short measurement times. It should however be noted that the response of high-sensitivity sensors outside the square-law region differs from that of thermal sensors so that only spectrally pure signals with unmodulated envelope (CW, FM, φM, FSK, GMSK) can be measured. Regarding the display linearity, greater measurement uncertainties than with thermal sensors are to be expected in this region due to frequency and temperature effects.

Medium-sensitivity diode sensors

The medium-sensitivity sensors **NRV-Z2** and **NRV-Z5** based on diode sensors with 20 dB attenuator pad close the gap between the thermal and the high-sensitivity sensors in applications where in the power range between –20 dBm and 0 dBm both high measurement speed and the thermal sensor characteristics are required at a time.

Given a continuous load capability of 2 W, this type of sensor is extremely robust.

Peak power sensors

The peak power sensors **NRV-Z31/ -Z32/-Z33** take a special place among diode sensors. They enable measurement of the peak envelope power (PEP) of modulated signals during signal peaks of 2 µs to 100 ms duration. They thus open up a large variety of applications, from the measurement of pulsed transmit power of TDMA mobile phones through special measurement tasks in applied physics to the measurement of sync pulse power of terrestrial TV transmitters. Peak power sensors from Rohde&Schwarz are available for the frequency range 30 MHz to 6 GHz in the power classes 20 mW (NRV-Z31), 2 W (NRV-Z32) and 20 W (NRV-Z33), the latter for direct power measurement at output stages.

DC to 40 GHz / 100 pW to 30 W GSM900/1800/1900,

Various models within a power class allow the handling of versatile waveforms:

- **Model 02** (of NRV-Z31) and **Model 05** (of NRV-Z32) are designed for general-purpose applications and are suitable for measuring the power of RF bursts from 2 µs width and at repetition rates from 10/s (NRV-Z31/model 02) and 25/s (NRV-Z32/model 05).

- **Model 03** (high-speed model of NRV-Z31/-Z33) can be used at repetition rates from 100/s and due to its higher measurement speed it is ideal for system applications and measurement of the sync pulse power of negatively modulated TV signals in line with the relevant standards for terrestrial television (NTSC, CCIR, British and OIRT). The picture content has no effect on the measurement result, while the effect of the sound carrier can be compensated using tabulated correction factors.

- **Models 04** of all peak power sensors are tailored to the requirements of TDMA radio networks and enable measurement of the transmit power of TDMA mobile stations to GSM and DECT standards.

The following table serves as a guide in choosing the suitable sensor for digital modulation:

Modulation	Time structure	Application	Suitable sensor	Measured parameter	Dynamic range
GMSK, GFSK (unmodulated envelope)	continuous	GSM, DECT base stations; same power in all timeslots	all sensors, without any restrictions	P_{avg}	50 to 80 dB
	one timeslot active, frame length <10 ms	GSM, DECT mobile stations	NRV-Z31/-Z32/-Z33 model 04	P_p (PEP) [1]	43 dB
QPSK, OQPSK	continuous	IS-95 CDMA, W-CDMA base stations	NRV-Z51 to -Z55	P_{avg}	50 dB
OFDM	continuous	DVB-T / DAB transmitters	NRV-Z51 to -Z55	P_{avg}	50 dB
π/4DQPSK, 8 PSK, 16QAM, 64QAM symbol rate: any	continuous	NADC, PDC, PHS, TETRA base stations; same power in all timeslots	NRV-Z51 to -Z55	P_{avg}	50 dB
π/4DQPSK, 8 PSK, 16QAM, 64QAM symbol rate <25 kS/s	continuous	NADC, PDC TETRA base stations; same power in all timeslots	NRV-Z31/-Z32/-Z33 model 02/03/05	PEP	43 dB
	one timeslot active, frame length ≤40 ms	NADC, PDC mobile stations	NRV-Z32, model 05	PEP	43 dB
			NRV-Z51	P_p	40 dB

Footnotes see end of data sheet

DECT, IS-95, CDMA, WCDMA, NADC, PDC, DAB, DVB ...

The right sensor for digital modulation

There are two main features of digitally modulated signals that have to be considered in power measurements:

- The pulsed envelope power to CDMA, DAB and DVB standards and all standards prescribing the modulation modes PSK, QAM and π/4DQPSK (e.g. NADC, PDC, PHS and TFTS) requires a differentiation between average power and peak power.
  All thermal power sensors can be used without any restrictions for average power measurements. Diode sensors may be used provided they are operated inside the square-law region. The peak power sensors of the NRV-Z31/-Z32/-Z33 series (models 02, 03 and 05) are suitable for measuring the peak value at symbol rates of up to 25 kS/s.

- In the case of transmission standards using TDMA structure, like GSM, DECT, NADC, PDC or PHS, the data stream for a channel is compressed to fit into one of several timeslots, so that the power measurement has to be carried out in a certain time interval. In the case of one active timeslot in the transmit signal (mobile station), the peak power sensors of the NRV-Z31/-Z32/-Z33 series can be used, with models 02, 03 and 05 being suitable for measuring the peak power and model 04 for measuring the average transmit power (GSM and DECT only).

Precision calibration

A power sensor can only be as precise as the measuring instruments used for its calibration. Therefore, the calibration standards used by Rohde&Schwarz are directly traceable to the standards of the German Standards Laboratory.

All data gained in calibration as well as the essential physical characteristics of the sensor, eg temperature effect, are stored in a data memory integrated in the sensor and can be read by the basic unit and considered in the measurements.

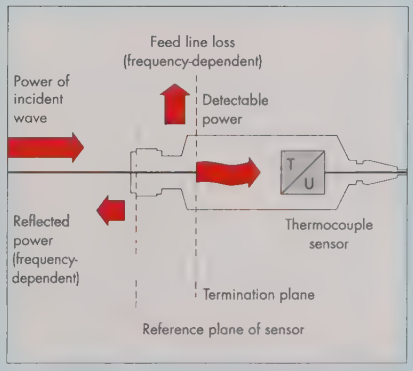
Since all Rohde&Schwarz power sensors feature absolute calibration, measurements can be started immediately after plugging the sensor into the basic unit without prior calibration to a 1 mW reference source. To activate the frequency-dependent calibration factors all the user needs to do is to enter the test frequency on the basic unit.

Calibration of the NRV-Z sensors is directly traceable to the standards of the German Standards Laboratory.

Power sensors are calibrated to the power of the incident wave.

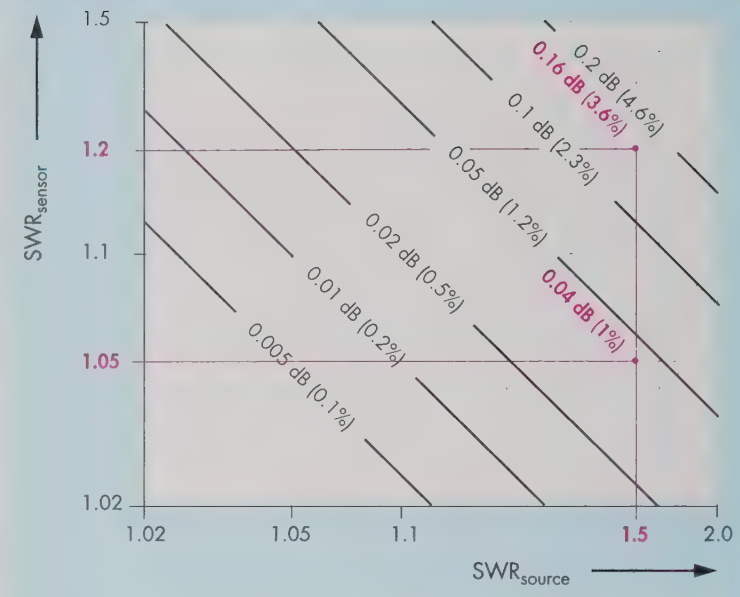
This ensures that with a matched source the available source power into 50 Ω (or 75 Ω) is measured.

With a mismatched source the power of the incident wave will differ from the available power according to the mismatch uncertainty.



Measurement accuracy and matching

The accuracy of power measurements is determined by diverse parameters, such as the measurement uncertainty in calibration, linearity or ambient temperature: parameters whose effect can directly be specified. In contrast, the effect of a mismatched power sensor can only be estimated if the source matching is known. Mismatch of source and sensor causes the device under test – the source – to supply a somewhat higher or lower power than for an exactly matched output. As shown in the graph on the right, the resulting measurement error can be several times greater than the measurement errors caused by all other parameters. Power sensors from Rohde&Schwarz therefore feature excellent matching to ensure optimum measurement accuracy even under conditions of strong reflections.



Maximum measurement error due to mismatch for source power available into 50 Ω (75 Ω). Values stated in dB and in % of power in W.

Example shown:
Power measurement on a source with SWR of 1.5.
A sensor with excellent matching with 1.05 SWR (eg NRV-Z5) generates a measurement error of as little as 0.04 dB (1%), while a SWR of 1.2 would result in a measurement error four times greater.

The basic units

All power sensors can be used with the following basic units from Rohde&Schwarz:

NRVD
- Modern dual-channel power meter
- Menu-guided operation
- IEC/IEEE-bus interface (SCPI)
- Ideal for relative measurements in two test channels (attenuation, reflection)
- Large variety of measurement functions
- Result readout in all standard units
- Many extras like 1 mW test generator, indication of measurement uncertainty etc

NRVS
- Cost-effective, single-channel power meter
- Manual operation like NRVD
- Many measurement functions
- Result readout in all standard units
- Analog output fitted as standard
- IEC/IEEE-bus interface (syntax-compatible with NRV/URV5)

NRVD

NRVS

URV 35

- Compact voltmeter and power meter for use in service, test shop and lab
- Unique combination of analog and digital display in form of moving-coil meter plus LCD with backlighting
- Many measurement functions
- Result readout in all standard units
- Choice of battery or AC supply operation
- RS-232-C interface

URV 55

Cost-effective single-channel voltmeter; similar to NRVS.

URV 35

URV 55

Sensors for voltage and level measurements

Probes and insertion units (data sheet PD 756.9816) open up further applications of the power meters:

RF Probe URV5-Z7

- For practically no-load measurements in non-coaxial RF circuits; frequency range 20 kHz to 1 GHz
- Comprehensive accessories, including adapters for 50 Ω and 75 Ω connectors

Insertion Units URV5-Z2/-Z4

- For level measurement between source and load in coaxial 50 Ω and 75 Ω systems. With an optimally matched load, power measurements from –60 to +53 dBm are possible even without directional coupler
- Frequency range 9 kHz to 3 GHz

DC Probe URV5-Z1

For low-load DC measurements in RF circuits from 1 mV to 400 V.

URV5-Z2/-Z4

Calibration Kit NRVC

Calibration Kit NRVC is used for fast, program-controlled calibration of Rohde&Schwarz Power Sensors NRV-Z up to 18 GHz as well as of Voltage Sensors URV5-Z. It is a valuable tool for calibration labs and all those who use a great number of these sensors and wish to perform on-site calibration. The measurement uncertainties are in line with data sheet specifications and comparable to those of a factory calibration.

Main features

- Traceable power calibration from DC to 18 GHz
- Measurement level from –30 dBm (1 µW) to +20 dBm (100 mW), depending on sensor
- High long-term stability of thermal power standard through DC voltage reference
- Traceable linearity calibration from –30 dBm to +33 dBm at 50 MHz
- Complete calibration of a sensor in approx. 15 minutes
- Easy operation thanks to Windows™ user interface
- Programming of data memories of NRV sensors using computed correction data
- Standard-conformal documentation of measurement results

Calibration Kit NRVC

Specifications

Model connector, impedance	Frequency range	Power meas. range, max. power	Max. SWR (reflection coefficient)	Zero offset [2]	Display noise [3]	Linearity uncertainty	Power coefficient
High-sensitivity diode sensors (RMS weighting up to 10 µW; NRV-Z3 up to 6 µW)							
NRV-Z4 N connector, 50 Ω	100 kHz to 6 GHz	100 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.1 to 100 MHz 1.05 (0.024) >0.1 to 2 GHz 1.10 (0.048) >2 to 4 GHz 1.2 0 (0.09) >4 to 6 GHz 1.35 (0.15)	±50 pW	20 pW	0.03 dB (0.7%) [4]	0
NRV-Z1 N connector, 50 Ω	10 MHz to 18 GHz	200 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.01 to 1 GHz 1.06 (0.03) >1 to 2 GHz 1.13 (0.06) >2 to 4 GHz 1.27 (0.12) >4 to 18 GHz 1.41 (0.17)	±100 pW	40 pW	0.03 dB (0.7%) [4]	0
NRV-Z6 PC-3.5 connector, 50 Ω	50 MHz to 26.5 GHz	400 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.05 to 0.1 GHz 1.30 (0.13) >0.1 to 18 GHz 1.20 (0.09) >18 to 26.5 GHz 1.40 (0.165)	±200 pW	80 pW	0.04 dB (1%) [4]	0
NRV-Z15 K connector [5] (2.92 mm), 50 Ω	50 MHz to 40 GHz	400 pW to 20 mW 100 mW (AVG) 100 mW (PK)	0.05 to 4 GHz 1.15 (0.070) >4 to 40 GHz 1.37 (0.157)	±200 pW	80 pW	0.04 dB (1%) [4]	0
NRV-Z3 N connector, 75 Ω	1 MHz to 2.5 GHz	100 pW to 13 mW 70 mW (AVG) 70 mW (PK)	1 MHz to 1 GHz 1.11 (0.05) >1to 2.5 GHz 1.20 (0.09)	±40 pW	16 pW	0.03 dB (0.7%) [4]	0
Medium-sensitivity diode sensors (RMS weighting up to 1 mW)							
NRV-Z5 N connector, 50 Ω	100 kHz to 6 GHz	10 nW to 500 mW 2 W (AVG) 10 W (PK)	100 kHz to 4 GHz 1.05 (0.024) >4 to 6 GHz 1.10 (0.048)	±5 nW	2 nW	0.03 dB (0.7%) [4]	0
NRV-Z2 N connector, 50 Ω	10 MHz to 18 GHz	20 nW to 500 mW 2 W (AVG) 10 W (PK)	0.01 to 4 GHz 1.05 (0.024) >4 to 8 GHz 1.10 (0.048) >8 to 12.4 GHz 1.15 (0.07) >12.4 to 18 GHz 1.20 (0.09)	±10 nW	4 nW	0.03 dB (0.7%) [4]	0
Thermal power sensors (RMS weighting in complete power measurement range)							
NRV-Z51 N connector, 50 Ω	DC to 18 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz 1.10 (0.048) >2 to 12.4 GHz 1.15 (0.07) >12.4 to 18 GHz 1.20 (0.09)	±60 nW	22 nW	0.02 dB (0.5%)	0
NRV-Z52 PC-3.5 connector, 50 Ω	DC to 26.5 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz 1.10 (0.048) >2 to 12.4 GHz 1.15 (0.07) >12.4 to 18 GHz 1.20 (0.09) >18 to 26.5 GHz 1.25 (0.11)	±60 nW	22 nW	0.02 dB (0.5%)	0
NRV-Z55 K connector [5] (2.92 mm), 50 Ω	DC to 40 GHz	1 µW to 100 mW 300 mW (AVG) 10 W (PK, 1 µs)	DC to 2 GHz 1.10 (0.048) >2 to 12.4 GHz 1.15 (0.07) >12.4 to 18 GHz 1.20 (0.09) >18 to 26.5 GHz 1.25 (0.11) >26.5 to 40 GHz 1.30 (0.13)	±60 nW	22 nW	0.02 dB (0.5%)	0
NRV-Z53 N connector, 50 Ω	DC to 18 GHz	100 µW to 10 W 18 W (AVG) 1 kW (PK, 1 µs) (see diagram page 10)	DC to 2 GHz 1.11 (0.052) >2 to 8 GHz 1.22 (0.099) >8 to 12.4 GHz 1.27 (0.119) >12.4 to 18 GHz 1.37 (0.157)	±6 µW	2.2 µW	0.03 dB (0.7%)	0.011 dB/W (0.25%/W)
NRV-Z54 N connector, 50 Ω	DC to 18 GHz	300 µW to 30 W [6] 36 W (AVG) 1 kW (PK, 3 µs) (see diagram page 10)	DC to 2 GHz 1.11 (0.052) >2 to 8 GHz 1.22 (0.099) >8 to 12.4 GHz 1.27 (0.119) >12.4 to 18 GHz 1.37 (0.157)	±20 µW	7 µW	0.03 dB (0.7%)	0.007 dB/W (0.15%/W)
Peak power sensors							
NRV-Z31 N connector, 50 Ω	30 MHz to 6 GHz [7]	1 µW to 20 mW 100 mW (AVG) 100 mW (PK)	0.03 to 0.1 GHz 1.05 (0.024) >0.1 to 2 GHz 1.10 (0.048) >2 to 4 GHz 1.20 (0.09) >4 to 6 GHz 1.35 (0.15)	±30 nW	3 nW	included in calibration uncertainty	0
NRV-Z32 N connector, 50 Ω	30 MHz to 6 GHz [7]	100 µW to 2 W **(model 04)**, 100 µW to 4 W [8] **(model 05)**; 1 W (AVG) 4 W (PK, 10 ms) 8 W (PK, 1 ms)	0.03 to 4 GHz 1.11 (0.052) >4 to 6 GHz 1.22 (0.099)	±3 µW **(model 04)** ±4 µW **(model 05)**	0.3 µW **(model 04)** 0.4 µW **(model 05)**	included in calibration uncertainty	0.044 dB/W (1.0%/W)
NRV-Z33 N connector, 50 Ω	30 MHz to 6 GHz [7]	1 mW to 20 W 18 W (AVG) 80 W (PK) (see diagram page 10)	0.03 to 2.4 GHz 1.11 (0.052) >2.4 to 6 GHz 1.22 (0.099)	±30 µW	3 µW	included in calibration uncertainty	0.015 dB/W (0.35%/W)

Footnotes see end of data sheet

Calibration uncertainties in dB (bold type) and in % of power reading

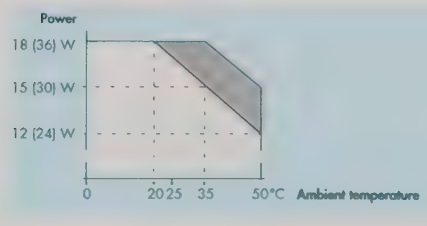
The calibration uncertainties in dB were calculated from the values in percent and rounded to two decimal places so that different values in percent may give one and the same value in dB.

Frequency in GHz	up to 0.03	>0.03 to 0.1	>0.1 to 1	>1 to 2	>2 to 4	>4 to 6	>6 to 8	>8 to 10	>10 to 12.4	>12.4 to 15	>15 to 16	>16 to 18	>18 to 20	>20 to 24	>24 to 26.5	>26.5 to 30	>30 to 35	>35 to 40
NRV- Z1	**0.07** 1.5	**0.07** 1.6	**0.07** 1.6	**0.07** 1.6	**0.08** 1.7	**0.08** 1.8	**0.09** 1.9	**0.10** 2.2	**0.10** 2.3	**0.11** 2.5	**0.14** 3.0	**0.15** 3.3						
NRV-Z2	**0.07** 1.4	**0.07** 1.5	**0.07** 1.5	**0.07** 1.5	**0.07** 1.6	**0.07** 1.6	**0.07** 1.6	**0.08** 1.8	**0.08** 1.8	**0.09** 2.1	**0.11** 2.4	**0.13** 2.8						
NRV-Z3	**0.06** 1.4	**0.06** 1.4	**0.07** 1.4	**0.07** 1.5	**0.07** 1.6	calibrated up to 2.5 GHz												
NRV-Z4	**0.05** 1.2	**0.06** 1.3	**0.06** 1.3	**0.06** 1.3	**0.06** 1.4	**0.07** 1.5												
NRV-Z5	**0.05** 1.1	**0.05** 1.2	**0.05** 1.2	**0.05** 1.2	**0.06** 1.3	**0.06** 1.3												
NRV-Z6		**0.06** 1.2	**0.06** 1.2	**0.06** 1.2	**0.06** 1.3	**0.06** 1.4	**0.07** 1.6	**0.08** 1.8	**0.08** 1.9	**0.10** 2.1	**0.11** 2.5	**0.13** 2.9	**0.09** 1.9	**0.09** 2.0	**0.09** 2.0			
NRV-Z15		**0.05** 1.1	**0.05** 1.2	**0.05** 1.2	**0.06** 1.3	**0.07** 1.6	**0.09** 2.0	**0.10** 2.2	**0.10** 2.3	**0.12** 2.7	**0.14** 3.1	**0.15** 3.4	**0.08** 1.8	**0.09** 2.0	**0.09** 2.0	**0.10** 2.2	**0.11** 2.4	**0.10** 2.2
NRV-Z31	**0.05** 1.2	**0.06** 1.2	**0.07** 1.6	**0.07** 1.6	**0.11** 2.4	**0.11** 2.5	0 to 10 mW											
	0.05 1.2	**0.06** 1.2	**0.07** 1.6	**0.07** 1.6	**0.15** 3.4	**0.16** 3.5	>10 mW to 20 mW											
NRV-Z32 (04)	**0.08** 1.7	**0.08** 1.7	**0.09** 2.0	**0.09** 2.0	**0.13** 2.9	**0.17** 3.8	0 to 1 W											
	0.08 1.7	**0.08** 1.7	**0.09** 2.0	**0.09** 2.0	**0.17** 3.7	**0.20** 4.5	>1 W to 2 W											
NRV-Z32 (05)	**0.08** 1.7	**0.08** 1.7	**0.09** 2.0	**0.09** 2.0	**0.13** 2.9	**0.17** 3.8	0 to 1 W											
	0.09 1.9	**0.09** 1.9	**0.10** 2.2	**0.10** 2.2	**0.25** 5.6	**0.28** 6.1	>1 to 4 W											
NRV-Z33	**0.08** 1.7	**0.08** 1.7	**0.09** 2.0	**0.09** 2.0	**0.14** 3.2	**0.17** 3.8	0 to 10 W											
	0.08 1.7	**0.08** 1.7	**0.09** 2.0	**0.09** 2.0	**0.18** 3.9	**0.20** 4.5	>10 W to 20 W											
NRV-Z51	9)	**0.05** 1.0[9)]	**0.05** 1.0	**0.05** 1.1	**0.05** 1.2	**0.06** 1.2	**0.06** 1.4	**0.07** 1.6	**0.07** 1.6	**0.09** 1.9	**0.10** 2.3	**0.12** 2.7						
NRV-Z52	9)	**0.05** 1.1[9)]	**0.06** 1.2	**0.06** 1.2	**0.06** 1.3	**0.06** 1.4	**0.07** 1.5	**0.08** 1.7	**0.08** 1.8	**0.10** 2.1	**0.11** 2.5	**0.13** 2.9	**0.08** 1.8	**0.09** 1.9	**0.09** 1.9			
NRV-Z53	9)	**0.07** 1.6[9)]	**0.07** 1.6	**0.07** 1.6	**0.10** 2.2	**0.10** 2.2	**0.10** 2.3	**0.12** 2.7	**0.13** 2.8	**0.16** 3.6	**0.17** 3.8	**0.18** 4.1						
NRV-Z54	9)	**0.08** 1.7[9)]	**0.08** 1.7	**0.08** 1.7	**0.10** 2.2	**0.10** 2.3	**0.11** 2.3	**0.12** 2.8	**0.13** 2.8	**0.16** 3.6	**0.17** 3.8	**0.18** 4.1						
NRV-Z55	9)	**0.05** 1.1[9)]	**0.05** 1.2	**0.05** 1.2	**0.06** 1.3	**0.06** 1.4	**0.07** 1.5	**0.08** 1.7	**0.08** 1.8	**0.10** 2.1	**0.11** 2.5	**0.13** 2.9	**0.08** 1.7	**0.09** 1.9	**0.09** 1.9	**0.10** 2.2	**0.11** 2.4	**0.10** 2.1

[illegible] in dB (bold type) and in % of power reading

T_{amb}	22 °C to 24 °C	18 °C to 28 °C		10 °C to 40 °C		0 °C to 50 °C	
		max.	typ.	max.	typ.	max.	typ.
NRV-Z1 to -Z5, -Z31	included in calibration uncertainty	**0.05** 1.0	**0.015** 0.3	**0.14** 3.0	**0.05** 1.0	**0.32** 7.0	**0.09** 2.0
NRV-Z6/-Z15		**0.03** 0.6	**0.005** 0.1	**0.09** 2.0	**0.02** 0.5	**0.18** 4.0	**0.05** 1.0
NRV-Z32		**0.06** 1.3	**0.02** 0.4	**0.16** 3.6	**0.06** 1.2	**0.37** 8.1	**0.10** 2.3
NRV-Z33		**0.06** 1.4	**0.02** 0.4	**0.19** 4.2	**0.06** 1.3	**0.41** 9.0	**0.11** 2.5
NRV-Z51/-Z52/-Z55		**0.02** 0.4	**0.005** 0.1	**0.06** 1.3	**0.02** 0.4	**0.09** 2 0	**0.02** 0.5
NRV-Z53/-Z54		**0.04** 0.8	**0.01** 0.2	**0.11** 2.5	**0.03** 0.7	**0.18** 4.0	**0.05** 1.0

Max. power as a function of ambient temperature for sensors NRV-Z33, NRV-Z53 and NRV-Z54. Values for NRV-Z54 in ( )



Grey area:
The maximum surface temperatures permitted to IEC 1010-1 are exceeded.
Provide protection against inadvertent contacting or apply only short-term load to sensor.

Supplementary data for Peak Power Sensors NRV-Z31/-Z32/-Z33

Waveform

Model	02	03	04	05
Min. burst width	2 µs	2 µs	200 µs	2 µs
Min. burst repetition rate [10]	10 Hz	100 Hz	100 Hz	25 Hz
Min. duty cycle [11]	5×10^{-4} (2×10^{-3})	10^{-3} (10^{-2})	2×10^{-2} (2×10^{-2})	5×10^{-4} (2×10^{-3})

Peak weighting error

NRV-Z32 (model 05)
Max. peak weighting errors in % of power reading for burst signals of TDMA mobile stations in line with GSM 900/1800/1900, PDC and NADC specifications:

Average burst power	GSM 900/1800/1900	NADC / PDC
10 mW to 2 W	**1.5** [1.5]	**5.5** [5.5]
1 mW to 10 mW	**1.5** [2.0]	**5.5** [6.5]
0.3 mW to 1 mW	**3.5** [4.5]	**6.5** [8]
0.1 mW to 0.3 mW	**8.0** [11]	**15** [20]

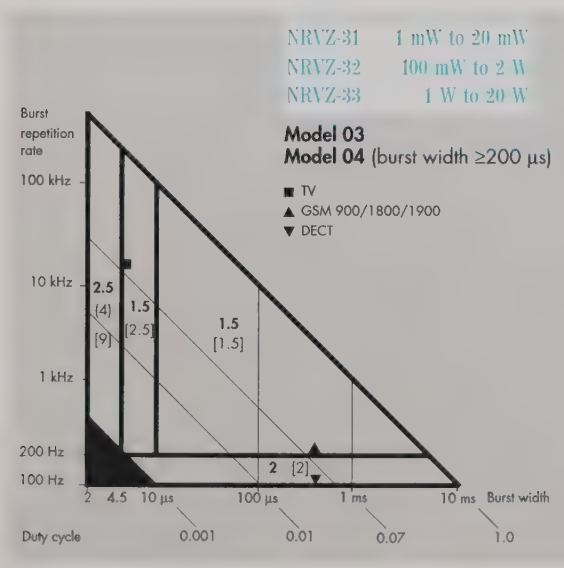
Values without brackets (bold type) T_{amb} = 18 °C to 28 °C
Values in [ ] 0 °C to 50 °C
For conversion into dB see table on the right.
For other waveforms the diagrams shown for NRV-Z31 model 02 apply approximately, with burst repetition rates of 10 Hz and 50 Hz corresponding to burst repetition rates of 25 Hz and 125 Hz of NRV-Z32.

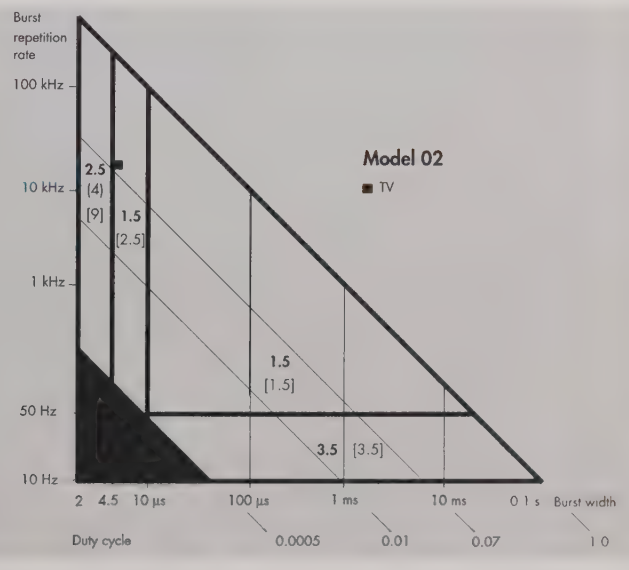
NRV-Z31/-Z32 (model 04)/-Z33
The maximum measurement errors specified in the following diagrams for burst signals with corresponding width and repetition rate compared to a CW signal of same power hold true for all peak power sensors (except NRV-Z32 model 05 – see above).

Numeric values: maximum error in % of power reading.
– without brackets (bold type): T_{amb} = 18 °C to 28 °C
– in ( ): 10 °C to 40 °C
– in [ ]: 0 °C to 50 °C
– black areas: not specified
For conversion into dB see table on the right
Where no value is specified for the temperature range 10 °C to 40 °C, the correct value is obtained by forming the average from the values specified for 18 °C to 28 °C and 0 °C to 50 °C.

Conversion of measurement error in % of power reading into dB:

%	dB
±1.5	–0.066/+0.065
±2	–0.088/+0.086
±2.5	–0.110/+0.107
±3	–0.132/+0.128
±3.5	–0.155/+0.149
±4	–0.177/+0.170
±5	–0.223/+0.212
±6	–0.269/+0.253
±7	–0.315/+0.294
±8	–0.362/+0.334
±9	–0.410/+0.374
±10	–0.458/+0.414
±11	–0.506/+0.453
±12	–0.555/+0.492
±13	–0.605/+0.531
±14	–0.655/+0.569
±15	–0.706/+0.607
±16	–0.757/+0.645
±18	–0.862/+0.719
±20	–0.969/+0.792



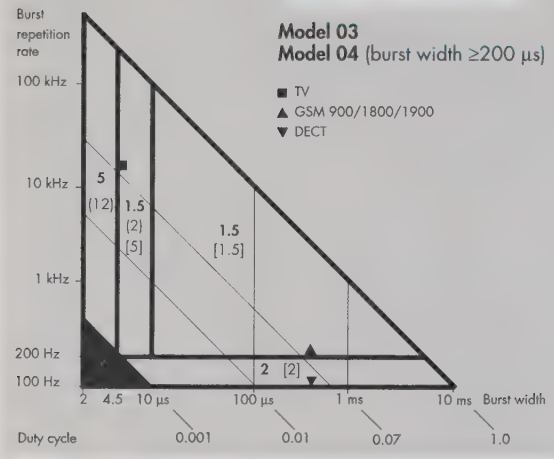


Footnotes see end of data sheet

NRVZ-31 100 µW to 1 mW
NRVZ-32 10 mW to 100 mW
NRVZ-33 100 mW to 1 W

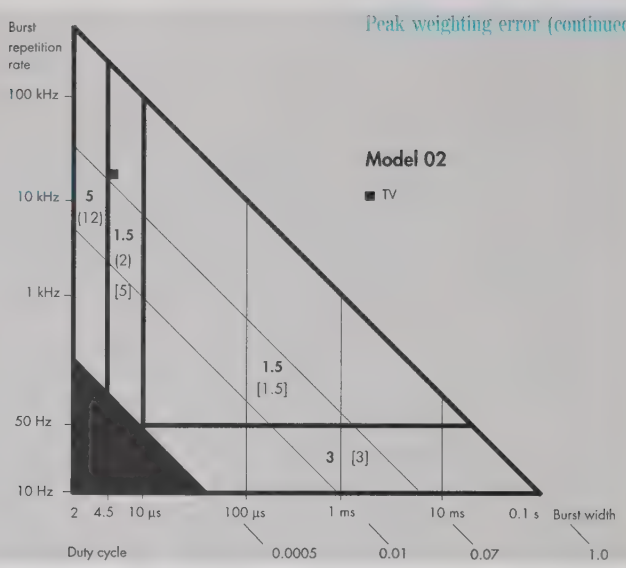
Model 03
Model 04 (burst width ≥200 µs)

■ TV
▲ GSM 900/1800/1900
▼ DECT



Model 02

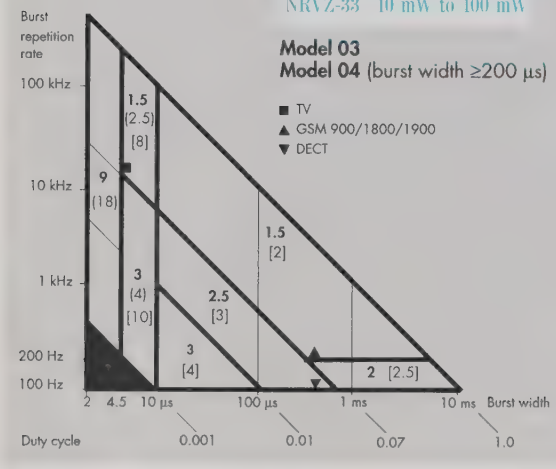
■ TV



NRVZ-31 10 µW to 100 µW
NRVZ-32 1 mW to 10 mW
NRVZ-33 10 mW to 100 mW

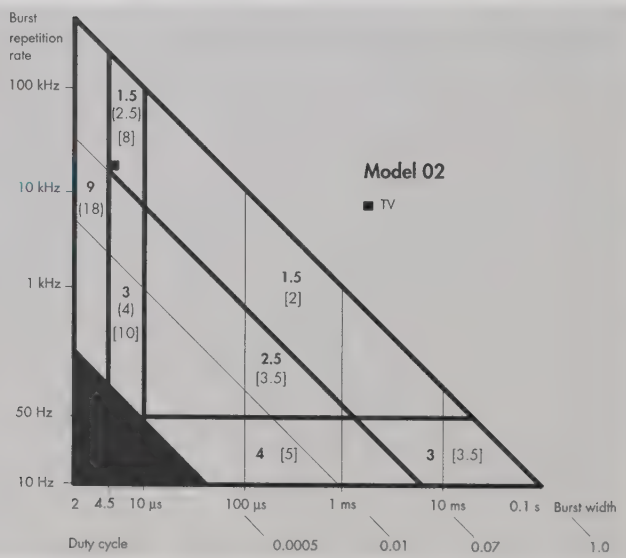
Model 03
Model 04 (burst width ≥200 µs)

■ TV
▲ GSM 900/1800/1900
▼ DECT



Model 02

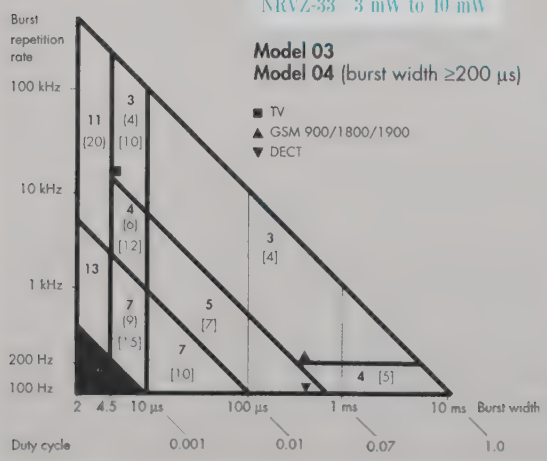
■ TV



NRVZ-31 3 µW to 10 µW
NRVZ-32 300 µW to 1 mW
NRVZ-33 3 mW to 10 mW

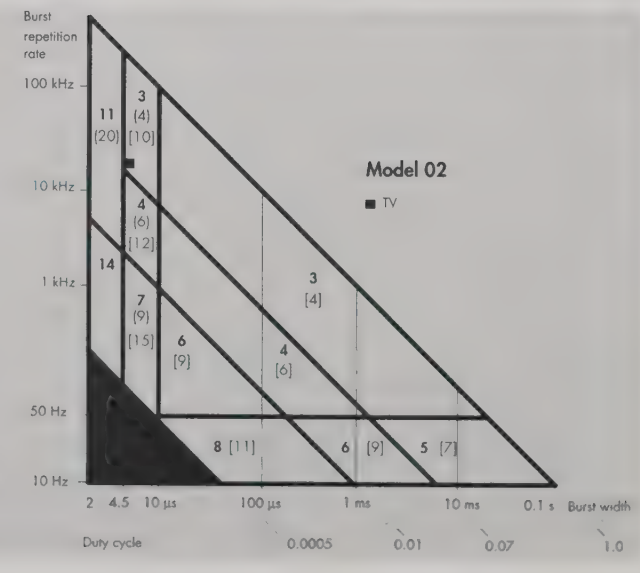
Model 03
Model 04 (burst width ≥200 µs)

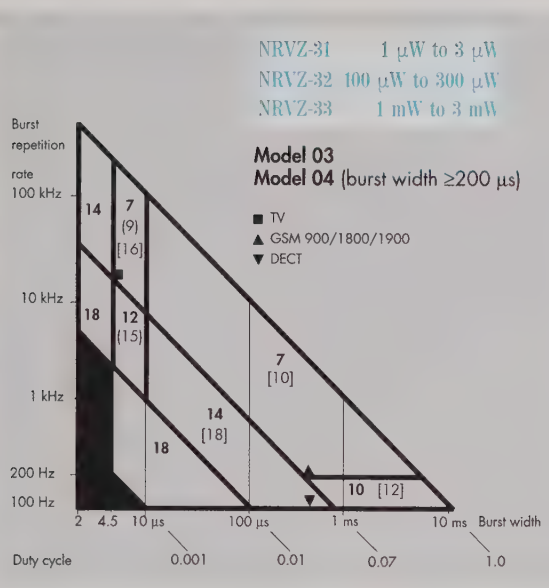
■ TV
▲ GSM 900/1800/1900
▼ DECT

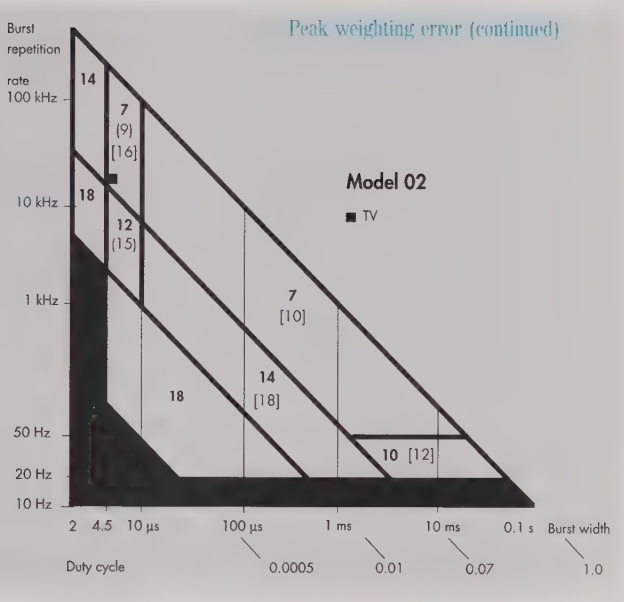


Model 02

■ TV







General data

Environmental conditions

Temperature ranges	meet DIN IEC 68-2-1/68-2-2
Operating	0 °C to +50 °C
Storage	–40 °C to +70 °C
Permissible humidity	max. 80%, without condensation
Vibration, sinusoidal	5 Hz to 55 Hz, max. 2 g; 55 Hz to 150 Hz, 0.5 g cont. (meets DIN IEC 68-2-6, IEC 1010-1 and MIL-T-28800 D class 5)
Vibration, random	10 Hz to 500 Hz, acceleration 1.9 g (rms) (meets DIN IEC 68-2-36)
Shock	40 g shock spectrum (meets MIL-STD-810 D, DIN IEC 68-2-27)
EMC	meets EN 50081-1 and 50082-1, EMC directive of EU (89/336/EEC), EMC law of the Federal Republic of Germany and MIL-STD-461 C (RE 02, CE 03, RS 03, CS 02)
Safety	meets EN 61010-1

Dimensions and weight

NRV-Z1 to -Z15/-Z31 NRV-Z51/-Z52/-Z55	120 mm × 37 mm × 31 mm; 0.35 kg
NRV-Z51, model 04	156 mm × 37 mm × 31 mm; 0.35 kg
NRV-Z32	190 mm × 37 mm × 31 mm; 0.42 kg
NRV-Z33, NRV-Z53	240 mm × 54 mm × 60 mm; 0.53 kg
NRV-Z54	298 mm × 54 mm × 60 mm; 0.68 kg

Length of connecting cable 1.3 m / 5 m (other lengths on request)

*) For use at RF connectors with high temperature difference to the environment of the power sensor, eg at the output of power attenuators.

Ordering information

High-Sensitivity Diode Sensors		
20 mW, 50 Ω, 18 GHz	NRV-Z1	0828.3018.02
with 5 m cable	NRV-Z1	0828.3018.03
13 mW, 75 Ω, 2.5 GHz	NRV-Z3	0828.3418.02
with 5 m cable	NRV-Z3	0828.3418.03
20 mW, 50 Ω, 6 GHz	NRV-Z4	0828.3618.02
with 5 m cable	NRV-Z4	0828.3618.03
20 mW, 50 Ω, 26.5 GHz	NRV-Z6	0828.5010.02
20 mW, 50 Ω, 40 GHz	NRV-Z15	1081.2305.02
Medium-Sensitivity Diode Sensors		
500 mW, 50 Ω, 18 GHz	NRV-Z2	0828.3218.02
with 5 m cable	NRV-Z2	0828.3218.03
500 mW, 50 Ω, 6 GHz	NRV-Z5	0828.3818.02
with 5 m cable	NRV-Z5	0828.3818.03
Thermal Power Sensors		
100 mW, 50 Ω, 18 GHz	NRV-Z51	0857.9004.02
with 3 m cable, thermally insulated*)	NRV-Z51	0857.9004.04
100 mW, 50 Ω, 26.5 GHz	NRV-Z52	0857.9204.02
10 W, 50 Ω, 18 GHz	NRV-Z53	0858.0500.02
30 W, 50 Ω, 18 GHz	NRV-Z54	0858.0800.02
100 mW, 50 Ω, 40 GHz	NRV-Z55	1081.2005.02
Peak Power Sensors		
20 mW, 50 Ω, 6 GHz	NRV-Z31	
– Standard model	– Model 02	0857.9604.02
– High-speed model	– Model 03	0857.9604.03
– TDMA model	– Model 04	0857.9604.04
2 W, 50 Ω, 6 GHz	NRV-Z32	
– TDMA model	– Model 04	1031.6807.04
– Universal model	– Model 05	1031.6807.05
20 W, 50 Ω, 6 GHz	NRV-Z33	
– High-speed model	– Model 03	1031.6507.03
– TDMA model	– Model 04	1031.6507.04
Calibration Kit		
Calibration Kit for Power Sensors 1 µW to 100 mW; DC to 18 GHz	NRVC	1109.0500.02
Verification Set for NRVC	NRVC-B1	1109.1007.02
Accessory Set for Linearity Measurements	NRVC-B2	1109.1207.02

Definitions

Measurement uncertainty

Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand. Regarding calibrations and data sheet specifications Rohde & Schwarz conforms to the relevant international guidelines[15] recommending the specification of an expanded uncertainty with a coverage factor k=2. With normally distributed measurement errors it can be assumed that the limits thus defined will be adhered to in 95% of all cases.

Calibration uncertainty

Expanded (k=2) uncertainty attributed to the calibration factors in the data memory of a sensor and hence smallest measurement uncertainty that can be attained for absolute power measurements under reference conditions[16]. The data sheet specifications for NRV sensors[17] are based on the measurement uncertainty in calibration plus an additional uncertainty for aging and wear and tear.

Mismatch uncertainty

Measurement uncertainty contribution that has additionally to be taken into account with a mismatched source, if the value measured by the power meter is to be used to determine the source power available with a matched load.

Linearity

Measure of a power meter's capability to express an increase/reduction of the measured power in a corresponding change of the reading. Linearity is affected by negative influences in the calibration of the sensor (linearity uncertainty), zero offset, display noise and influence of the basic unit (upon change of the measurement range). With diode sensors operated outside the square-law region the following parameters may additionally influence the linearity: frequency-dependent linearity errors, temperature effect, harmonics.

Linearity uncertainty

Smallest expanded (k=2) uncertainty that can be attained for relative power measurements under reference conditions[18] relative to the sensor-specific reference power. The magnitude of the linearity uncertainty is mainly determined by the calibration method.

Frequency-dependent linearity error

Linearity errors outside the square-law region caused by the voltage-dependent junction capacitance of a diode detector and noticeable from about ¼ of the upper frequency limit. Rohde&Schwarz specifies the error relative to the sensor-specific reference power.

Power coefficient

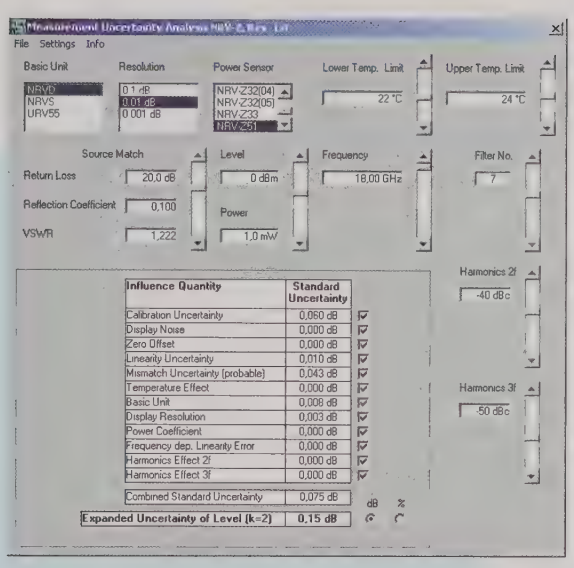
Measure of the sensitivity of a high-power sensor to the self-heating of the attenuator pad at the input. Multiplication by the average power of the test signal yields the maximum variation of the attenuation value that causes a variation of the reading by the same amount. As a function of the variation speed of the measured quantity, this behaviour may cause linearity errors. The thermal time constants of the attenuator pads used lie in the range of seconds.

Zero offset

Error in the measurement result caused by the power meter in the form of a systematic, absolute measurement error independent of the magnitude of the measured power. Zero offsets can very easily be recognized if the reading is other than zero with no power applied. The relative measurement uncertainty caused by zero offsets is inversely proportional to the measured power.

Footnotes see end of data sheet

Definitions (continued)



User interface of measurement uncertainty analysis program

Display noise

Statistical component superimposed on the reading whose absolute magnitude is independent of the measured power. Therefore the relative measurement uncertainty caused by display noise is inversely proportional to the measured power.

Peak weighting error

Measurement error of a peak power sensor in case of a pulsed but otherwise unmodulated RF signal with squarewave envelope (burst) compared to a CW signal of same power.

Harmonics effect

Harmonics may adversely affect the measurement accuracy of diode sensors, and compared to a thermal sensor the reading is increased or decreased depending on the phase position relative to the fundamental. Thermal sensors always measure the power of the total signal and therefore exclusively provide RMS weighting of the harmonics – provided these are within the specified frequency range. For details on the behaviour of diode sensors please refer to the Rohde&Schwarz brochure on Voltage and Power Measurements (PD0757.0835). As a rule of thumb it can be assumed that the harmonics effect for power ratings below 1 µW (–30 dBm) with high-sensitivity sensors and 100 µW (–10 dBm) with medium-sensitivity sensors is negligible. Harmonics below –60 dBc can be considered to be noncritical irrespective of the power measured.

Temperature effect

Effect of the ambient temperature on the accuracy of the sensor. Rohde&Schwarz specifies the residual relative measurement error after internal correction of the temperature response of the sensor, i.e. the maximum value and a typical value corresponding approximately to one standard deviation. The specifications apply without any restrictions to thermal sensors and to diode sensors operated inside the square-law region, whereas for diode sensors outside the square-law region they refer exclusively to CW signals.

Influence of basic unit

Rohde&Schwarz specifies the maximum measurement error caused by the basic unit in absolute power measurements at different ambient temperatures.

Definitions (continued)

Calculation of total measurement uncertainty

The calculation or at least estimation of the measurement uncertainty should be part of every power measurement. Therefore, Rohde&Schwarz offers the Measurement Uncertainty Analysis Program NRV-Z*), a tool that allows fast calculation of the measurement uncertainty without any basic knowledge being required. For manual calculation, the individual influencing parameters should also be combined statistically, as described on page 14, for example. The influencing parameters to be taken into account are listed in the table below.

Type of sensor ⇨	Thermal sensor or diode sensor inside square-law region		Diode sensor outside square-law region + CW signal		Peak power sensor	
Type of measurement ⇨	absolute	relative [20]	absolute	relative [20]	absolute	relative [20]
Influencing parameter						
Mismatch uncertainty	●	○ [19]	●	○ [19]	●	○ [19]
Calibration uncertainty	●		●		●	●
Linearity uncertainty	●	●	●	●		
Frequency-dependent linearity error			●	●		
Power coefficient	○ [12]	○ [12]			○ [12]	○ [12]
Harmonics effect	○ [13]	○ [13]	●	●	●	●
Temperature effect	●		●	●	●	●
Zero offset	●	●			●	●
Display noise	●	●			●	●
Basic unit	●	○ [14]	●	○ [14]	●	○ [14]
Peak weighting error					●	●

The table below shows an example of the measurement uncertainty being manually calculated for an absolute power measurement with Thermal Power Sensor NRV-Z51 at 1.9 GHz / –10 dBm:

	Specification		Standard uncertainty
Influencing parameter	**Value**	**Weighting / distribution**	u_i
Mismatch uncertainty (SWR_{source} = 1.2)	0.038 dB	1.4 σ/u	0.027 dB
Calibration uncertainty	0.050 dB	2 σ/normal	0.025 dB
Linearity uncertainty	0.020 dB	2 σ/normal	0.010 dB
Temperature effect (18°C to 28°C)	0.005 dB	1 σ	0.005 dB
Zero offset	60 nW	2 σ/normal	0.001 dB
Display noise (filter 7)	4 x 22 nW	2 σ/normal	0.002 dB
Basic unit NRVS	0.017 dB	1.7 σ/square	0.010 dB
		Expanded uncertainty	
		$(2 \times \sqrt{\Sigma u_i^2}) = 0.080$ dB (1.8%)	

*) Application Note 1GP43, can be downloaded from the R&S Homepage, under Products & More, Application Notes.

Footnotes

1) With GSM and DECT the envelope is unmodulated so that the determination of the average burst power can be reduced to a measurement of the peak power (PEP).

2) Within 1 h after zero adjustment with a probability of 95%, permissible temperature variation 1 °C, after 2 h warmup of basic unit with sensor.
NRV-Z53 and NRV-Z54: after measurement of high-power signals, larger zero offsets may temporarily occur (up to 0.5 mW for NRV-Z53, 2 mW for NRV-Z54 after application of rated power).

3) Noise specifications (2 standard deviations) refer to filter 11, temperature 18 °C to 28 °C. With the most sensitive measurement range selected on NRVS, NRVD and URV55, filter 11 is set automatically (autofilter mode, resolution HIGH). Noise values for other filter settings are obtained by multiplication with the factors given in the table below. The specified measurement times are typical values in remote-control mode:

Filter No. (NRVS, NRVD, URV55)		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Noise multiplier		51	32	23	16	11.3	8	5.6	4	2.8	2	1.4	1.0	0.7
Meas. time (s)	NRV-Z1 to -Z6/-Z15	0.045	0.05	0.06	0.08	0.15	0.27	0.49	0.95	1.85	3.6	7.2	14.5	28.5
	NRV-Z31, model 02	1.04	1.04	1.05	1.07	1.13	1.24	1.44	1.84	2.7	4.3	7.5	14	27
	NRV-Z31, model 03/04	0.135	0.14	0.15	0.17	0.23	0.34	0.54	0.94	1.77	3.4	6.6	13	26
	NRV-Z32, model 04	0.135	0.14	0.15	0.17	0.23	0.34	0.54	0.94	1.77	3.4	6.6	13	26
	NRV-Z32, model 05	0.435	0.44	0.45	0.47	0.53	0.64	0.84	1.24	2.07	3.7	6.9	14	27
	NRV-Z33	0.135	0.14	0.15	0.17	0.23	0.34	0.54	0.94	1.77	3.4	6.6	13	26
	NRV-Z51 to -Z55	0.115	0.12	0.13	0.15	0.21	0.32	0.52	0.92	1.75	3.4	6.6	13	26

In autofilter mode the following settings are made as a function of measurement range and resolution:

			Filter No.						
Resolution	HIGH	0.001 dB	11	9	7	7	7	7	7
	MEDIUM	0.01 dB	9	7	3	3	3	3	3
	LOW	0.1 dB	7	3	0	0	0	0	0
Meas. range	NRV-Z1/-Z3/-Z4/-Z6/-Z15		10 nW	100 nW	1 µW	10 µW	100 µW	1 mW	20 mW
	NRV-Z2/-Z5		1 µW	10 µW	100 µW	1 mW	10 mW	100 mW	500 mW
	NRV-Z31		–	1 µW	10 µW	100 µW	1 mW	20 mW	–
	NRV-Z32		–	100 µW	1 mW	10 mW	100 mW	2 (4) W	–
	NRV-Z33		–	1 mW	10 mW	100 mW	1 W	20 W	–
	NRV-Z51/-Z52/-Z55		10 µW	100 µW	1 mW	10 mW	100 mW	–	–
	NRV-Z53		1 mW	10 mW	100 mW	1 W	10 W	–	–
	NRV-Z54		10 mW	100 mW	1 W	10 W	30 W	–	–

Footnotes (continued)

4) Further causes of linearity errors are described in the section "Definitions" under the keyword "Linearity".
The linearity errors specified in the table below are referred to the sensor-specific reference power. Since the errors are proportional to frequency and power, the specified maximum values can be expected to occur at the individual interval limits only.

Frequency-dependent linearity errors for diode sensors

			Frequency		
		10 MHz to 4 GHz	**4 GHz to 8 GHz**	**>8 GHz to 13 GHz**	**>13 GHz to 18 GHz**
NRV-Z1	–17 dBm to +3 dBm 20 µW to 2 mW	0	0 to +0.09 dB 0 to +2%	0 to +0.21 dB 0 to +5%	0 to +0.25 dB 0 to +6%
	> +3 dBm to +13 dBm > 2 mW to 20 mW	0	0 to +0.17 dB 0 to +4%	0 to +0.41 dB 0 to +10%	0 to +0.49 dB 0 to +12%
NRV-Z2	+3 dBm to +23 dBm 2 mW to 200 mW	0	0 to +0.09 dB 0 to +2%	0 to +0.21 dB 0 to +5%	0 to +0.25 dB 0 to +6%
	> +23 dBm to +27 dBm > 200 mW to 500 mW	0	0 to +0.15 dB 0 to +3.5%	0 to +0.33 dB 0 to +8%	0 to +0.41 dB 0 to +10%
		100 kHz to 1.5 GHz	**>1.5 GHz to 3 GHz**	**>3 GHz to 6 GHz**	
NRV-Z4	–17 dBm to +3 dBm 20 µW to 2 mW	0	0 to +0.09 dB 0 to +2%	0 to +0.25 dB 0 to +6%	
	> +3 dBm to +13 dBm > 2 mW to 20 mW	0	0 to +0.17 dB 0 to +4%	0 to +0.41 dB 0 to +10%	
NRV-Z5	+3 dBm to +23 dBm 2 mW to 200 mW	0	0 to +0.09 dB 0 to +2%	0 to +0.25 dB 0 to +6%	
	> +23 dBm to +27 dBm > 200 mW to 500 mW	0	0 to +0.15 dB 0 to +3.5%	0 to +0.33 dB 0 to +8%	
		0.05 GHz to 0.2 GHz	**>0.2 GHz to 4 GHz**	**>4 GHz to 14 GHz**	**>14 GHz to 26.5 GHz**
NRV-Z6	–17 dBm to +3 dBm 20 µW to 2 mW	–0.11 dB to +0.02 dB –2.5% to +0.5%	0	0 to +0.02 dB 0 to +0.5%	0 to +0.07 dB 0 to +1.5%
	> +3 dBm to +13 dBm > 2 mW to 20 mW	–0.2 dB to +0.07 dB –4.5% to +1.5%	0	0 to +0.07 dB 0 to +1.5%	0 to +0.19 dB 0 to +4.5%
		0.05 GHz to 0.2 GHz	**>0.2 GHz to 4 GHz**	**>4 GHz to 12.4 GHz**	**>12.4 GHz to 40 GHz**
NRV-Z15	–17 dBm to +3 dBm 20 µW to 2 mW	±0.01 dB ±0.2%	0	0 to +0.04 dB 0 to +1%	0 to +0.09 dB 0 to +2%
	> +3 dBm to +13 dBm > 2 mW to 20 mW	–0.02 dB to +0.01 dB –0.5% to +0.2%	0	0 to +0.09 dB 0 to +2%	0 to +0.33 dB 0 to +8%

5) K connector is a trademark of Anritsu Corp.

6) In the temperature range 35 °C to 50 °C only short-term or reduced load (see diagram page 10) permitted if there is no protection against inadvertent contacting.

7) The lower frequency limit is 10 MHz for ambient temperatures up to 28 °C.

8) 4 W peak power corresponds to an average power of approx. 2.1 W of a mobile to NADC or PDC standard.

9) For frequencies below 50 MHz, no calibration factors are stored in the EPROM of the sensor.
Therefore, frequency-response correction should not be used in this range and a calibration uncertainty of 2% be assumed.

10) The burst repetition rate is the reciprocal value of the burst period T.

11) The values in parentheses should not be exceeded in remote-controlled operation. Otherwise it is not ensured that the first value measured after triggering is a settled reading. Repeat triggering until steady results are output or provide for an appropriate delay before triggering after power to be measured has been applied.

12) Sensors with attenuator pad only.

13) At upper limit of square-law region.

14) To be considered when measuring in different ranges.

15) ISO Guide to the Expression of Uncertainty in Measurement. International Organization for Standardization, Geneva, Switzerland, ISBN: 92-67-10188-9, 1995.
Radio Equipment and Systems (RES); Uncertainties in the measurement of mobile radio equipment characteristics. ETSI Technical Report ETR028, June 1997, 3rd Edition, European Telecommunications Standards Institute. Valbonne, France.

Footnotes (continued)

16) Sensor temperature 22 °C to 24 °C, matched source, CW signal with sensor-specific reference power, >50 dB harmonic suppression for diode sensors.
Influence of basic unit neglected (eg after calibration).
The sensor-specific reference power is
1 µW to 10 µW for high-sensitivity diode sensors,
0.1 mW to 1 mW for medium-sensitivity diode sensors,
1 mW for NRV-Z51/-Z52/-Z55,
10 mW to 100 mW for NRV-Z53 and
10 mW to 300 mW for NRV-Z54.
For the peak power sensors NRV-Z31/-Z32/-Z33 the specified calibration uncertainties are valid in the total power range, however with a harmonic suppression of 60 dB or more.

17) Calculated for an average sensor of the relevant type. The uncertainties stated in the calibration report may slightly differ since they are determined taking into account the individual characteristics of the sensor and of the calibration system used. Usually the values are better than the data sheet specs; they may occasionally be somewhat poorer at specific frequency values.

18) Thermal sensors and diode sensors operated inside the square-law region:
No restrictions on part of the sensor, only the influence of the basic unit and zero offset should be negligible (sufficient measurement power, basic unit calibrated, ambient temperature 15 °C to 35 °C).
Diode sensors operated outside the square-law region:
Sensor temperature 22 °C to 24 °C, CW signal with harmonics suppression >60 dB, frequency within the range without frequency-dependent linearity uncertainties, influence of basic unit and zero offset negligible (sufficient measurement power, basic unit calibrated).

19) For power-dependent source matching.

20) At constant test frequency.

Certified Environmental System ISO 14001
Certified Quality System ISO 9001

Fax Reply (Power Sensors NRV-Z)

❑ **Please send me an offer**

❑ **I would like a demo**

❑ **Please call me**

❑ **I would like to receive your free-of-charge CD-ROM catalogs**

Others: _____

_____

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Name: _____

Company/Department: _____

Position: _____

Address: _____

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Country: _____

Telephone: _____

Fax: _____

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E-mail: CustomerSupport@rohde-schwarz.com

ROHDE&SCHWARZ

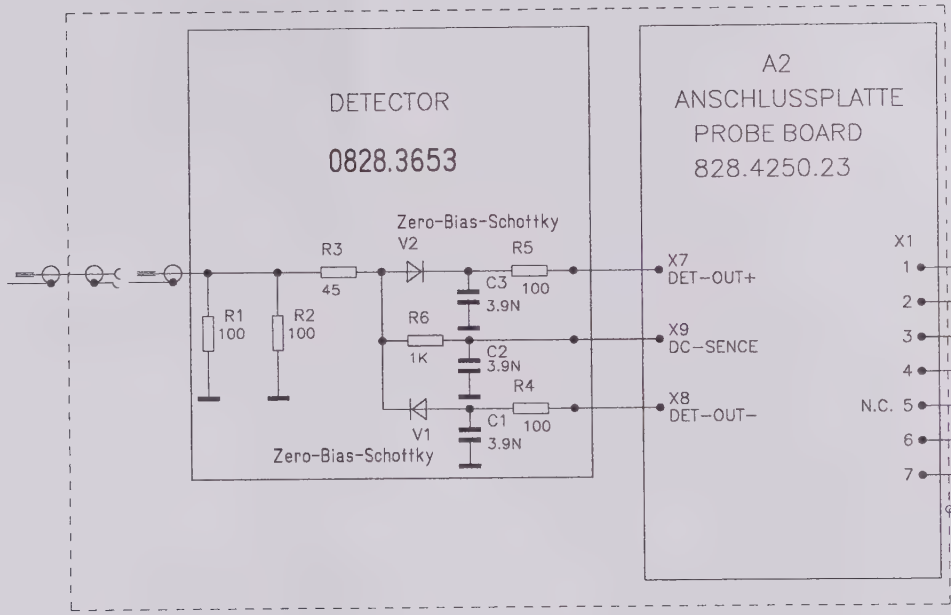
Schaltteillisten
Stromläufe
Bestückungspläne

Part lists
Circuit diagrams
Components plans

Listes des pièces détachées
Schémas de Circuit
Plans des composants

(R 29500 Bl 2)
0995.1000 BL 2

FUER DIESE UNTERLAGE
BEHALTEN WIR UNS ALLE RECHTE VOR



Bearbeitet mit
RoSy-Editor

ROHDE&SCHWARZ	04		22.01.97	SR					MEZ1	Datum	
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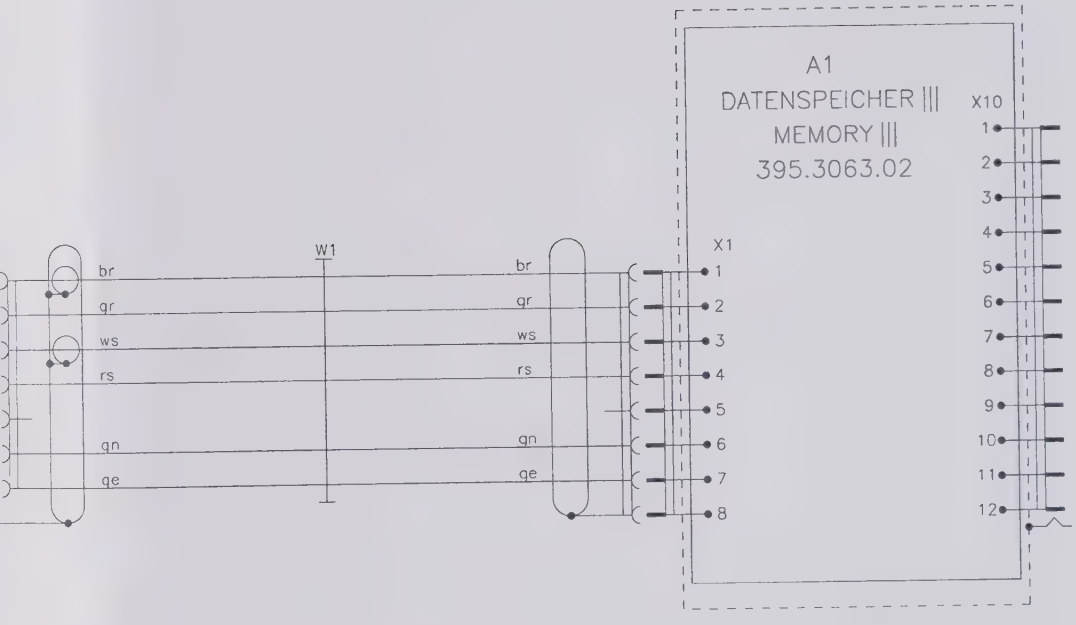


PROBE	A1 MEMORY III			
	S1a	S1b	S2a	S2b
NRV-Z4	off	off	off	off

ACHTUNG: EGB !
ELEKTROSTATISCH GEFAEHRDETE BAUELEMENTE ERFORDERN EINE BESONDERE HANDHABUNG.
ATTENTION ESD !
ELECTROSTATIC SENSITIVE DEVICES REQUIRE A SPECIAL HANDLING

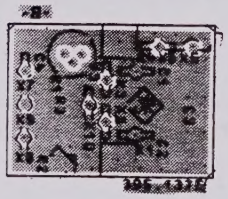
VARIANTENERKLAERUNG/VERSIONS

VAR02 = GRUNDAUSFUEHRUNG
MOD02 = BASIC MODEL
VAR03 = MIT 5M ANSCHLUSSKABEL
MOD03 = WITH CONNECTING CABLE 5M LENGHTS

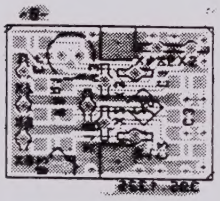
Benennung NRV-Z4 LEISTUNGSMESSKOPF 50 OHM
POWER SENSOR 50 OHM
ZU GERAET NRV-Z4

Zeichn.-Nr. 828.3618.01 S
BLATT-NR 1
REG.-I.V. 828.3618.V
ERSTE Z. 828.3618.C

Ansicht und Leitungsführung Bauteilseite
View of tracks on component side



Ansicht und Leitungsführung Lötseite
View of tracks on solder side



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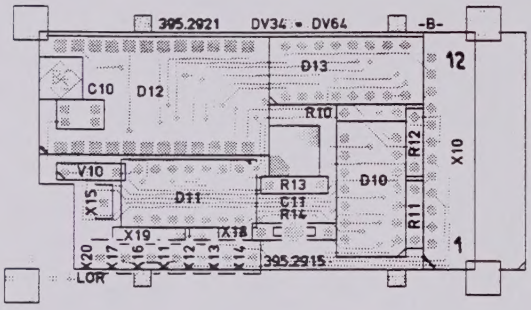
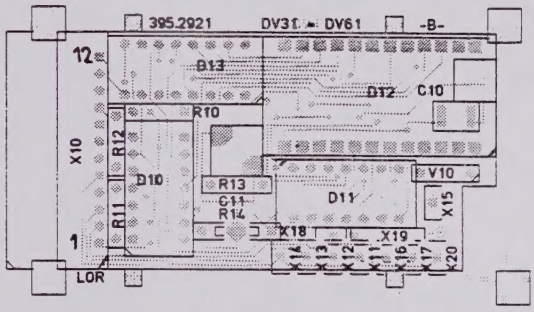
C 39963 (2) 06.88 Li	Maße ohne Toleranzangabe	Maßstab 1 : 1	
		Halbzeug Werkstoff	
	1KGU Tag Name	Benennung	
	Bearb 12.85 Li	Sensorplatte Sensor board	Z
	Gepr		
	Norm		
	ROHDE&SCHWARZ	Dokumenten-Nr 395.1319	Blatt-Nr 2
Änd Zust Änderungs-Mitteilung Tag Name	Dokumentar URV 5 - Z2	Ers. f. 395.1019 V	ersetzt d. 395.1019

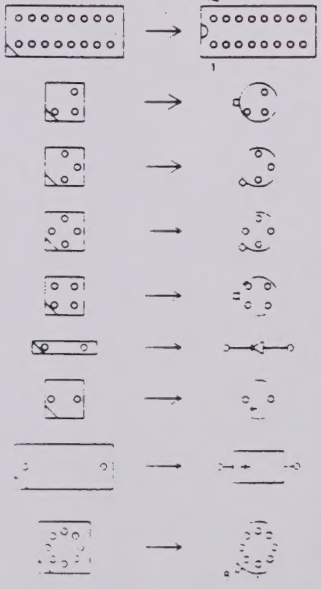
Ansicht und Leitungsführung Bauteilseite
View of tracks on component side





Ansicht und Leitungsführung Lötseite
View of tracks on solder side

Symbolschlussel



Achtung! MOS-Bauteile
Caution. MOS components

B		9.83	LI	Maße ohne Toleranzangabe	Maßstab 1 : 1
C	41367	1.89	Hi		Halbzeug Werkstoff
				1KGU Tag Name	Benennung
				Bearb 9.83 LI	Datenspeicher Memory
				Gepr	Z
				Norm	
				ROHDE&SCHWARZ	Zeichn.-Nr 395.2915
Änd Dat	Änderungs-Mitteilung	Tag	Name	Gerät URV5-Z7	Bl 2
				Bg 395.2615V	Ersatz f. 395.2680

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MP MASTER
MA34463